United States
Department of
Agriculture

Economic
Research
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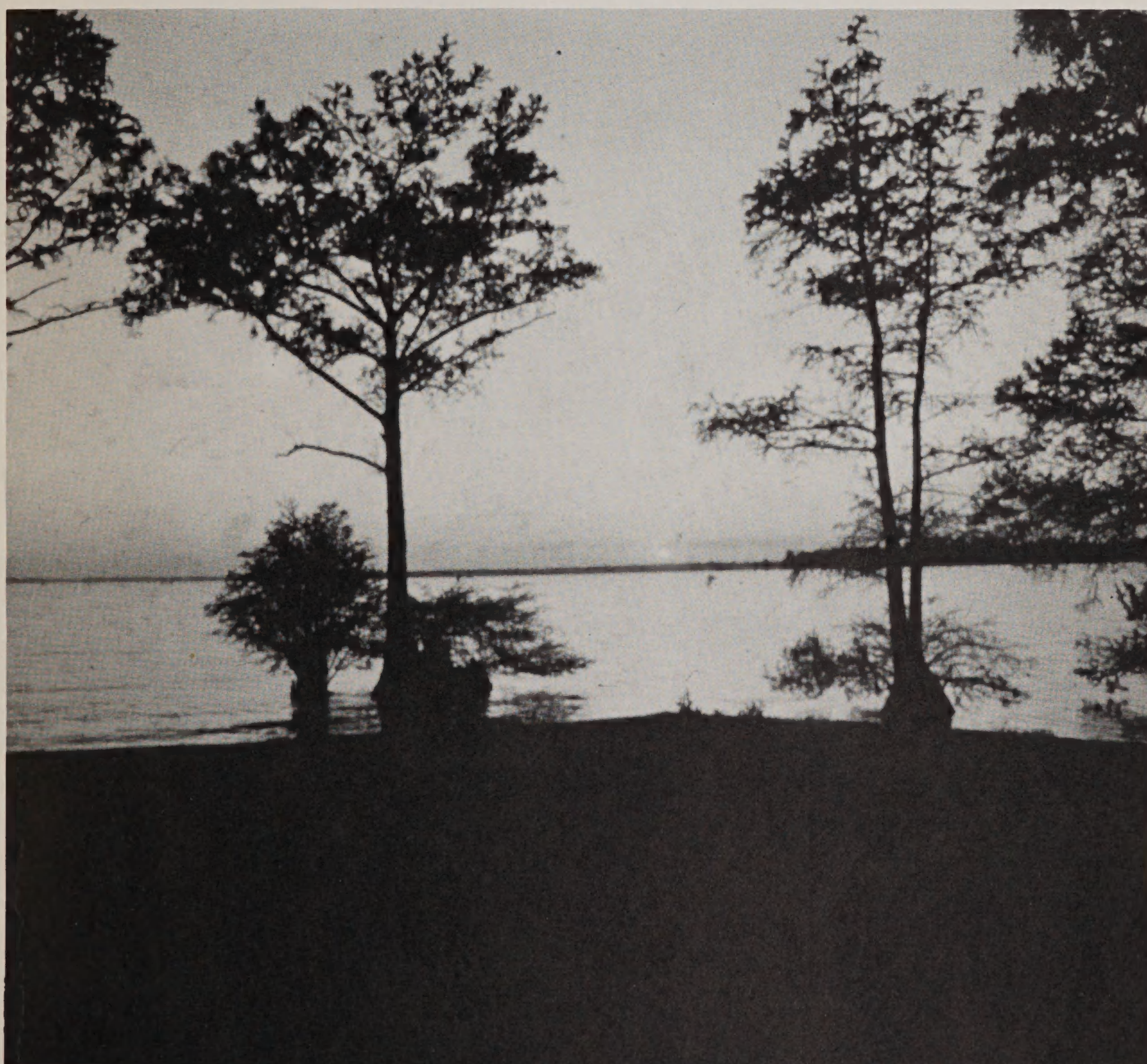
Forest
Service

Soil
Conservation
Service

Cooperating
Agencies

Chowan-Pasquotank River Basins

Water and Related Land Resources Study



C H O W A N -- P A S Q U O T A N K R I V E R B A S I N S

WATER AND RELATED LAND RESOURCES STUDY

UNITED STATES DEPARTMENT OF AGRICULTURE

Economic Research Service

Forest Service

Soil Conservation Service

and Other Cooperating Agencies

Prepared by Soil Conservation Service
Richmond, Virginia

Preface

In October 1970, the U. S. Army Engineer District, Norfolk, requested the U. S. Department of Agriculture (USDA) to make a study of the Chowan River Basin under authority of Section 204, Flood Control Act of June 30, 1948.

The Agricultural Appropriation Act for Fiscal Year 1973 provided funds for USDA studies of the Chowan River Basin. These funds were authorized by Section 6 of Public Law 83-566.

At the request of the involved state agencies the study was amended in 1976 to include the Pasquotank River Basins and the Dismal Swamp.

Technical appendices and other background information are available at the Virginia State Office of the Soil Conservation Service.

The USDA has provided an appraisal of the land and water resources of the basins and aided in planning development of the basins' resources. The study was conducted by the Soil Conservation Service, the Forest Service, and the Economic Research Service in cooperation with the North Carolina Department of Natural Resources and Community Development, the U. S. Army Engineer Districts - Norfolk and Wilmington, the Virginia State Water Control Board, the North Carolina Soil and Water Conservation Commission, the Virginia Soil and Water Conservation Commission, and the North Carolina-Virginia Resources Management Committee.

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U.S. Customary to Metric (SI) Units of Measurement

U.S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
acres	0.4047	hectares
bushels	35.24	liters
feet	0.3048	metres
cubic feet	0.02832	cubic metres
gallons per minute	0.003785	cubic metres per second
million gallons per day	0.0438	cubic metres per second
inches	25.4	millimetres
miles	1.609	kilometres
square miles	2.589	square kilometres
pounds	0.454	kilograms
tons	0.908	metric tons
tons per acre	2.244	metric tons per hectare

To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula:

$$C = (5/9)(F - 32)$$

CHAPTER 1
SUMMARY

Resource Base

The Chowan-Pasquotank basins are located in southeastern Virginia and the northeastern portion of North Carolina, with a drainage area of 9,300 square miles. The recorded history of the area dates back to 1587 and the "Lost Colony" founded by Sir Walter Raleigh. The basins have traditionally been agricultural areas and still bear the scars of poor farming practices of the 18th and 19th centuries.

There has been rapid population growth along the coast, particularly in the Norfolk area. The Piedmont and Coastal Plain areas have experienced little population growth and an actual decline in some areas. The coastal areas have a mix of manufacturing, tourism, government and agricultural based industries. Employment in other areas is predominantly agricultural based industries.

The climate is hot and humid, with plentiful rainfall and a long growing season. The terrain ranges from the steep hills of the Piedmont and the gently rolling Coastal Plain to the flat, wet soils of the Atlantic Coast Flatwoods.

The Piedmont soils are for the most part weathered from metamorphic and igneous rocks. They are generally well drained and on moderate to steep slopes. Where lands were farmed, a large portion of the A horizon eroded away during the 18th and 19th centuries due to poor farming methods. Cropland erosion is still a serious problem. Coastal Plain soils were mostly formed from marine and alluvial sediments. Most of the soils have a seasonably high water table and need drainage for the best yields. There are few well drained soils in the Atlantic Coast Flatwoods. When drainage is provided, these soils prove to be some of the most productive in the basin.

Fifty-five percent of this basin is in forest, 19 percent in cropland, 2 percent pasture and 4 percent in other agricultural uses. Other non-agricultural [1/] uses make up 20 percent of the total area. Land use trends show a continuing decrease in forest and shift of crop production from the Piedmont region to the Atlantic Coast Flatwoods. About a third of the cropland is considered adequately treated and projections indicate very slow progress in land treatment. Pulpwood and lumber are the major forestry products. Swine production is important and the major crops are corn, wheat, soybeans, and peanuts.

Water is plentiful but heavily used, particularly groundwater. The best potential reservoir sites are in the Piedmont, but the major demand for water is in the coastal areas. Municipal and industrial demand for water is projected to double in the Norfolk area by 2020. Although irrigation demand is low at present, a dramatic increase is projected in the future, with an associated development of farm ponds for water storage.

[1/] Federal non-cropland, urban, built-up, and small water areas

Water quality is generally good in most of the basins except during low flows. However, in the lower Chowan River and Albemarle Sound high concentrations of nutrients are causing serious algal blooms that have adversely affected fishing and water-based recreation.

There is an abundance of sport and commercial fishing capability in the basins. There will continue to be an abundance, if the water quality improves in Albemarle Sound. Game is plentiful throughout the basins and should continue to be. A number of threatened and endangered species are found in the extensive wetland areas. The wetland areas are also the areas where cropland is increasing and rapid urbanization is occurring.

Problems

Erosion is a major problem in the Virginia portion of the basins. The main areas of concern are cropland, roadbank, and shoreline erosion. The average erosion rate for cropland is 10 tons per acre per year. In some areas the rate is as high as 50 tons per acre per year. Roadbanks in many areas are scraped bare periodically, rather than being maintained by mowing only. This causes erosion rates as high as 300 tons per acre per year on some roadbanks. Over 600,000 tons per year are eroding from 450 miles of shoreline.

Sediment resulting from erosion increases flood hazards, reduces reservoir capacity, and increases water treatment costs. The nutrients associated with this sediment contribute to the algal blooms in Albemarle Sound.

Flood damages in the basins have been relatively minor, because most of the flood plains are forested. Flood control structures cannot be economically justified in most locations. The coastal areas are subject to tidal flooding and hurricane damage. There has been rapid development along the coast for several years, but there have been no major tropical storms, since the early 60's. There is a potential for significant damages, when hurricanes return.

Natural wetland areas are being reduced by the development of homes, vacation cottages, businesses, recreation sites, and by private projects to drain and convert wetlands to cropland. The policy of the U. S. Department of Agriculture is to discourage such conversions by withholding technical and financial assistance for drainage practices and by helping to inform the public about wet soil hazards and flooding hazards. This policy is not sufficient to prevent the private development and drainage of wetlands.

Excess soil moisture and poor surface drainage significantly restricts crop production on about 302,000 acres of cropland. Only about 55,000 acres of this area will obtain improved drainage systems under ongoing programs. The Department provides technical assistance for on-farm cropland drainage practices and financial assistance as well for drainage outlet systems for groups of landowners. However, such assistance is constrained where providing drainage outlets may adversely affect wetlands or natural channels.

Water supply problems are projected to be a major concern in the basins. Groundwater supplies are being threatened by saltwater intrusion due to large withdrawals in some areas. Several small communities need a dependable source of water for future growth. The City of Virginia Beach is facing a severe shortfall in future water supplies. The City of Norfolk is also facing a shortfall, and even though it is not within the basins, much of its water supply is.

Surface water quality has been a minor problem, but the non-point source pollution situation is projected to steadily worsen. Planned improvements in sewage treatment will barely keep pace with population growth. Land treatment without an accelerated program plan will improve erosion problems only slightly. Animal waste and industrial pollutants may increase and further degrade water quality, although the State Water Control Board is actively addressing these problems. Presently, sediments, algal blooms, and disease among fish populations threaten the fishing industry in the Chowan River and Albemarle Sound.

High-quality hardwood timber supplies are declining due to poor management practices which encourage the removal of only the best hardwood trees, with little consideration for future growth and production. Softwood timber supplies are declining due to failure to regenerate softwood stands on logged sites best suited to softwood growth.

Large amounts of imported energy are used in present agricultural practices. The energy is used directly as fuel and indirectly through the use of commercial fertilizers. Local sources of energy remain largely undeveloped.

Suggested Plan

Various land treatment options were examined using a linear programming model. The model indicated that optimum solutions for erosion control were significantly different for various approaches. An important finding is that total direct and indirect costs can be less for a mix of land treatment measures that reduce cropland erosion by 72 percent than for a mix that prevents any field from exceeding an erosion rate of 4 tons per acre and only results in a 64 percent reduction of total cropland erosion.

Alternative plans are also discussed in a general way for Flood Control, Water Supply, Water Quality, Wetland Preservation, and for Energy Development and Efficiency. Conceptual plans for Economic Efficiency and Environmental Quality are presented in Chapter 5.

The suggested plan presents a list of recommendations to be pursued in more detailed investigations by local state and federal agencies.

CHAPTER 2
RECOMMENDATIONS AND IMPLEMENTATION

If no action is taken in the Chowan-Pasquotank basins, there will be continued degradation of water quality, loss of farmland through erosion and development, loss of wetlands, flood damages, water shortages, and degraded fish and wildlife habitat. Unfortunately there is no simple solution to all these problems. A compromise must be worked out between often conflicting goals and objectives.

During the course of the study six watersheds were selected for more detailed study. They are Emporia Reservoir, Greensville Co., Va.; Flat Rock Creek, Lunenburg Co., Va.; North Landing River and Back Bay, Virginia Beach, Va.; Little Nottoway River, Nottoway Co., Va.; Northwest River, Chesapeake, Va.; and Waqua Creek, Brunswick Co., Va. We recommend that watershed projects be developed to implement practices for improved land treatment and water quality protection on these watersheds. The approaches and techniques that should be developed in these watersheds are:

1. Provide the optimum cost sharing rate necessary to encourage increased landowner participation in the selected conservation practices. This should be implemented by the Department of Agriculture.

2. As a short term solution for water quality problems, conservation plans should be developed that emphasize the most cost effective erosion control practices. These practices should emphasize sediment delivery reduction over large areas rather than soil loss tolerance levels. They should conserve energy and promote proper fertilizer use encourage integrated pest management, and be attractive to farmers. This should be implemented by landowners in cooperation with Conservation Districts assisted by the Soil Conservation Service.

3. The conservation plans for individual landowners should be supplemented with watershed programs to reduce transport of water borne sediments, nitrogen, and phosphorous by:

    a. Treating critical erosion areas including those on streambanks, roadbanks, and shorelines, and

    b. Installing animal waste management systems and practices to reduce runoff from barnyards.

4. For the long term problem of loss of productive land through erosion, a strong program should be developed. This program could include terrace construction, land use conversion to pasture or forest, and agricultural land set asides. This program should also examine the standards and specifications for practices eligible for cost sharing. Many of these standards are outdated, not cost effective, and hinder efforts to apply land treatment. This program should be coordinated through all agencies in the Department of Agriculture.

5. Develop an agressive educational program for rural energy conservation. Develop and distribute sample plans for reducing energy used in cultivation, fertilization, and harvesting operations, solar heating and drying, windmills, ethanol production and use, methane digesters, energy conserving crop practices, etc. Determine the feasibility of promoting fuelwood production as a viable timber management objective, taking into account future industrial wood needs and current timber stand characteristics. This should be implemented by private businesses and encouraged by the Department of Agriculture, Department of Energy, and state agencies.

6. Provide additional support to local and state agencies to discourage urban and residential development on flood plains, wetlands, and prime farmlands by providing maps and other information about these areas. Complete detailed soil surveys for the basin area. This should be implemented by the local and state agencies with assistance by SCS.

7. Provide assistance to local agencies for acquisition of important wetland fish and wildlife habitat areas. Provide assistance to landowners to improve fish and wildlife habitat areas, especially where rare or endangered species exist. This should be implemented by private organizations, Conservation Districts, and RC&D Projects with assistance from the Soil Conservation Service.

8. Develop water supplies for Jarrett, Va.; Kenbridge, Va.; Burkeville, Va.; and Seaboard, N.C. This should be implemented by state and local agencies in conjunction with an areawide water supply plan.

9. Regrade eroding roadbanks and seed with conservation plants and/or trees where possible and practical. This should be implemented by local and state agencies with assistance from RC&D projects or Conservation Districts.

10. Identify and treat eroding shoreline areas that can be protected with vegetation. Structural measures, such as revetments and groins, should only be installed where the property value justifies the cost. This should be implemented by landowners with assistance of local, state, and federal agencies.

11. Expand flood plain management programs within the basins to determine flood hazards and potential solutions on a site specific basis. This should be implemented by local and state agencies with assistance of the Soil Conservation Service and the National Oceanic and Atmosphere Administration.

12. Develop an agressive educational program aimed at the promotion of intensive timber management. Develop and distribute information regarding: (1) the costs and benefits of hardwood sawtimber management; and (2) softwood regeneration on sites suited to softwood growth. Encourage the development of timber management plans by non-industrial private landowners. Program activities could be implemented by state forestry agencies, with assistance provided by the Department of Agriculture.

13. Accelerate technical and financial assistance for drainage systems for existing cropland with soil wetness limitations, especially where increasing production on these soils will affect costs and production losses on other lands to be treated to reduce erosion. Help design drainage outlets to avoid the permanent alteration of wetlands or natural channels. Encourage coordination of drainage system designs within watershed areas by including drainage in small watershed projects. This should be implemented by conservation districts assisted by SCS.

CHAPTER 3
RESOURCE BASE AND FUTURE WITHOUT PLAN

Location and General Description

The Chowan-Pasquotank basins are located in southeastern Virginia and the northeastern portion of North Carolina (fig. 1). The basins have a drainage area of 9,300 square miles, 53 percent in North Carolina and the remainder in Virginia. The basins include all the land draining into Albemarle Sound except for the drainage of the Roanoke River. Also included are the coastal areas from Virginia Beach to Hatteras Inlet. All or part of 13 counties in North Carolina and 16 in Virginia are in the study area.

The Chowan-Pasquotank River basins were divided into five subareas for easier presentation. Each subarea is made up of counties with similar characteristics and problems.

About 20 percent of the study area is in the Piedmont Physiographic Province in Virginia, which consists of rolling hills and narrow valleys. About 35 percent of the area is in Coastal Plain and consists of gently sloping hills with broad valleys. Many of these valleys are wooded swamps. Thirty percent is in the Atlantic Coast Flatwoods and is generally flat land with many swamps and tidal estuaries (fig. 1). About 15 percent is open water.

The Chowan River basin is drained by three major tributaries: the Meherrin, the Nottoway, and the Blackwater Rivers. The Meherrin and the Nottoway Rivers begin in the Piedmont as generally fast flowing streams, then become slow rivers as they pass through swamp and marshland in the Coastal Plain. The Blackwater originates in the Coastal Plain and drains mildly sloping and flat country as it passes through wooded swampland. The Chowan River itself is a tidal estuary. The U.S. Geologic Survey's hydrologic unit numbers for these rivers are 03010201 through 03010204 (fig. 2). The Pasquotank River basin makes up the remainder of the study area. It is drained by several rivers, streams, swamps, and tidal marshes along the Virginia and North Carolina coastline.

History of the Study Area

The study area has one of the longest recorded histories in North America as it contains the site of the "Lost Colony" of Roanoke, founded by Sir Walter Raleigh in 1587. A few years later, Captain John Smith explored along the rivers of the basins and encountered the local Indian tribes.

Although many of the early colonists were more interested in treasure than agriculture, famine soon forced the colonists to apply the farming methods used by the Indians. Wheat and oats were supplemented by Indian crops such as corn, tobacco, peas, beans, and potatoes.

Colonization proceeded slowly, in waves which included the English, French Huguenots, Swiss, and finally, the Scottish Highlanders. Many settlers migrated from established colonies in Virginia, Pennsylvania, and South Carolina. By 1740 the entire area was thinly settled.

Farming methods were crude and wasteful. Instead of crop rotation, farmers abandoned one field for another, planting tobacco in the best fields, and corn, wheat, and vegetables on poorer land. This kind of farming depleted the soil and encouraged the waste of top soil by erosion. It is estimated that an average of 4.5 to 7 inches of topsoil were lost in the Piedmont. To some extent this kind of farming continues today. Clearing the longleaf pine of the Coastal Plain and the mixed hardwoods of the Piedmont led to a natural growth of forest industry in the basins. This coincided with English encouragement of forestry as a cash crop to supply naval stores of timber, tar, pitch, rosin, and turpentine. Most of the forests have regrown and today support a large lumber and paper industry.

Livestock, especially hogs, were gradually introduced by the beginning of the 18th century. From its earliest years, swineherds drove hogs to the area from as far away as Kentucky to have the animals killed and cured in the "Old Virginia" way.

The growing agricultural economy was disrupted during the Revolutionary War. General Cornwallis based his troops within the Chowan River basin. From there he made raids on Richmond, Williamsburg, and Norfolk. After the Revolution, life settled back into the old pattern. Aristocratic plantation owners used slave labor to produce tobacco in the Coastal Plain, and small subsistence farmers in the Piedmont produced corn, wheat, cattle, hogs, and whiskey.

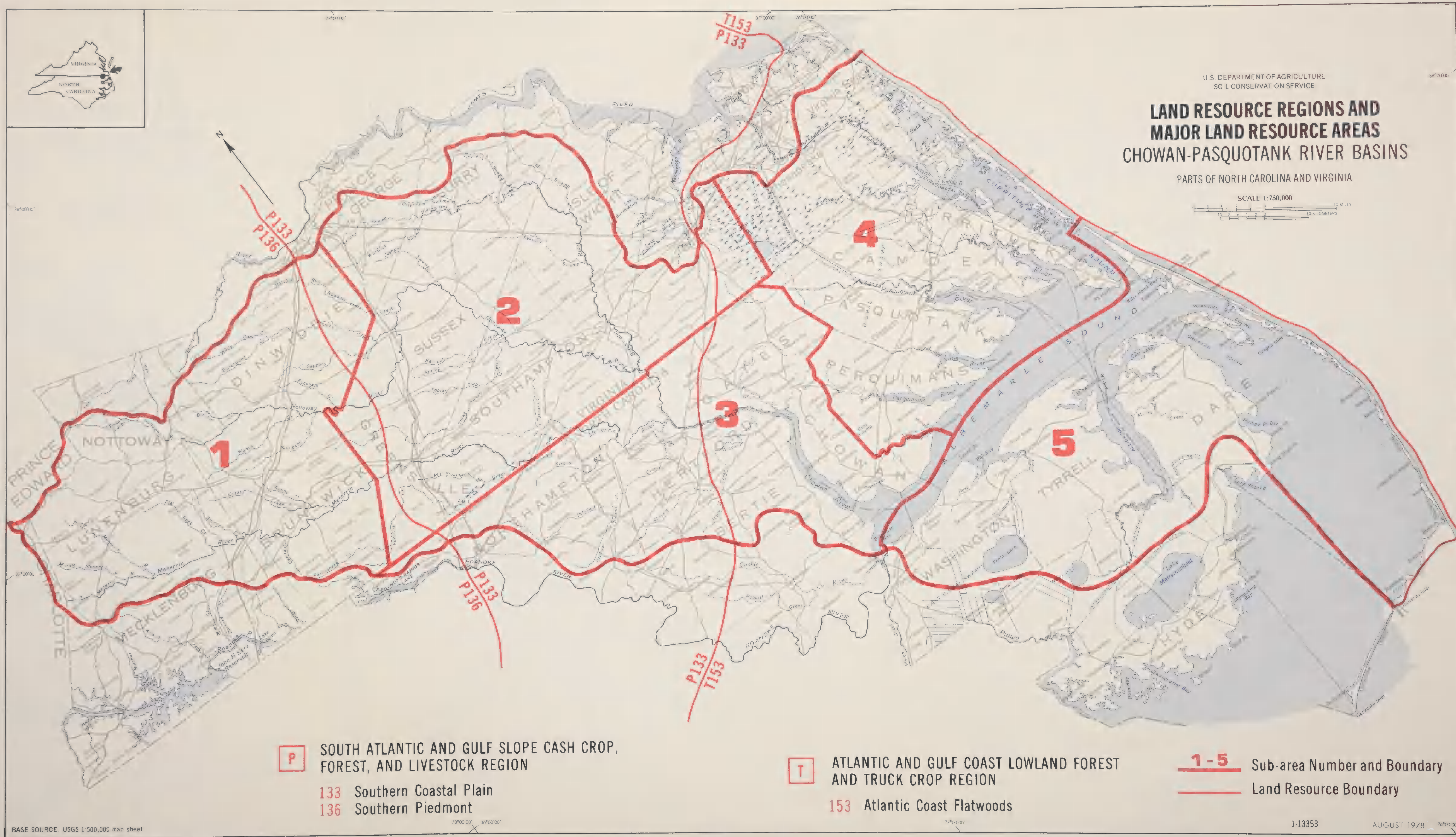
Following the recession of 1837, the area was opened through plank roads, railroads, and steamboat navigation. Cheap labor and water power in the Piedmont area contributed to agricultural prosperity and the beginnings of manufacturing and commerce. Tobacco, and later, cotton were the staple crops of the Coastal Plain and Piedmont valleys along the Virginia-North Carolina line. The discovery of the new leaf and a new curing process led to production increases in tobacco which blunted the thrust of manufacturing in the area. Manufacturing declined, as it was considered an inferior occupation to farming.

The Civil War disrupted the plantation system which was already feeling the effects of competition from rich, newly settled land in the West. A system of sharecropping entered the area's agriculture which influenced production until after World War II. Between 1880 and 1900 the Piedmont underwent some industrialization, including expansion of textile mills, wood product industries, and manufacturing of tobacco products. The combination of part-time factory employment and tenant farming characterized agriculture in the basins until very recently. Part-time farming is still prevalent, but most tenant farming operations have been replaced by large rental farming operations.

Population

Past Trends

The total population has grown in the last 25 years at an increasing rate. Population grew at an average rate of 0.4 percent between 1950 and 1960, but at 1.8 percent a year in the next decade. This trend was caused by increasing industrialization and new employment opportunities.


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
LAND RESOURCE REGIONS AND MAJOR LAND RESOURCE AREAS
CHOWAN-PASQUOTANK RIVER BASINS
PARTS OF NORTH CAROLINA AND VIRGINIA
SCALE 1:750,000
VIRGINIA
NORTH CAROLINA
1
2
3
4
5
NOTTOWAY
LUNENBURG
DINWIDDIE
SUSSEX
SOUTHAMPTON
SURRY
ISLE OF WIGHT
PRINCE GEORGE
PRINCE EDWARD
MECKLENBURG
BRUNSWICK
GREENSVILLE
NORTHAMPTON
HERTFORD
BERTIE
GATES
CHOWAN
PERQUIMANS
PASQUOTANK
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T153
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SOUTH ATLANTIC AND GULF SLOPE CASH CROP, FOREST, AND LIVESTOCK REGION
133 Southern Coastal Plain
136 Southern Piedmont
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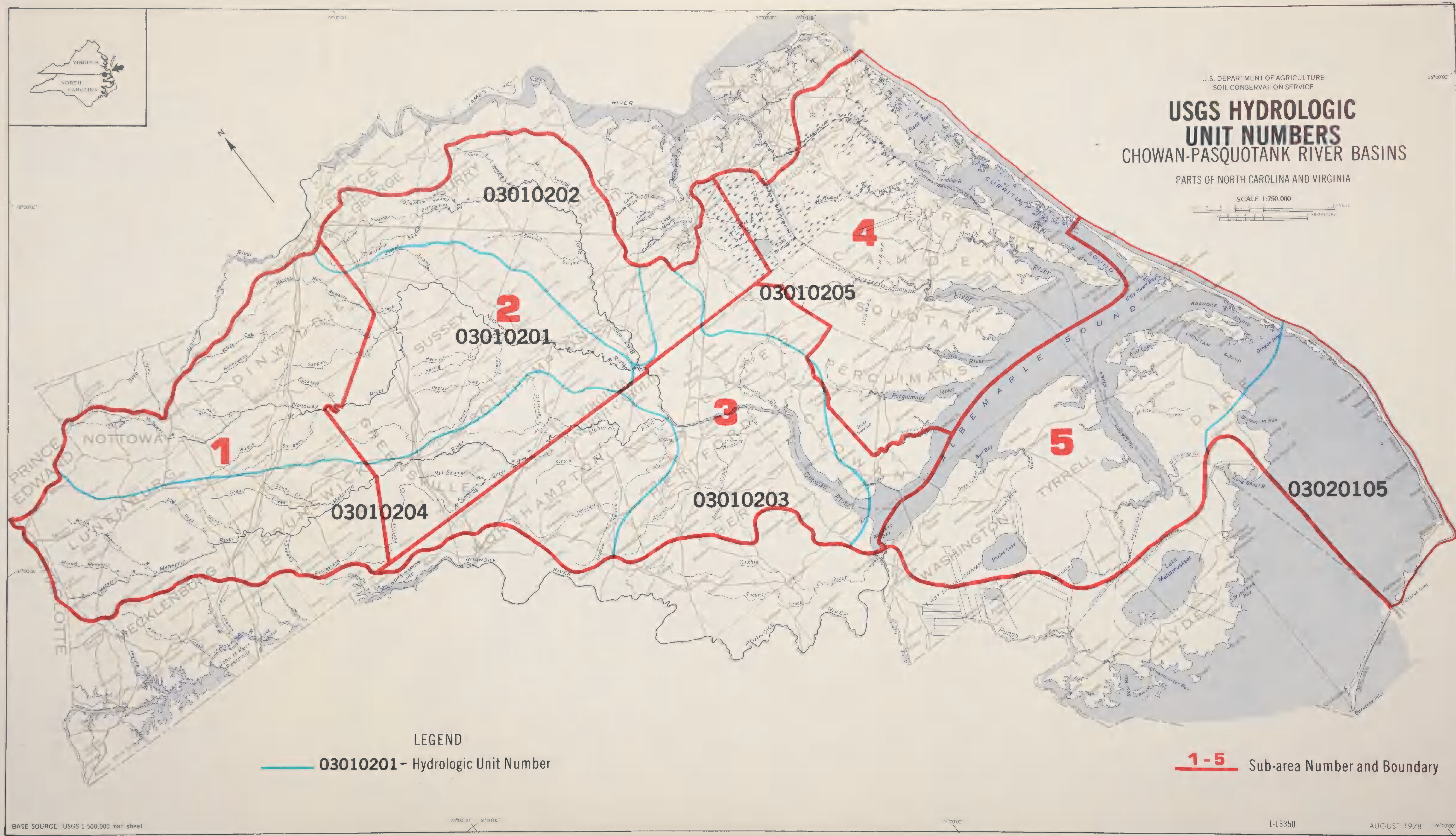
ATLANTIC AND GULF COAST LOWLAND FOREST AND TRUCK CROP REGION
153 Atlantic Coast Flatwoods
1 - 5 Sub-area Number and Boundary
Land Resource Boundary
BASE SOURCE: USGS 1:500,000 map sheet.
1-13353
AUGUST 1978
USDA-SCS HYATTSVILLE, MD 1978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SOIL CONSERVATION SERVICE
USGS HYDROLOGIC UNIT NUMBERS
CHOWAN-PASQUOTANK RIVER BASINS
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VIRGINIA
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N
03010202
03010201
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ALBEMARLE SOUND
CURRITUCK SOUND
ROANOKE RIVER
JAMES RIVER
Chowan River
Pasquotank River
Perquimans River
Nottoway River
Meherrin River
Lake Mattamuskeet
Phelps Lake
LEGEND
03010201 – Hydrologic Unit Number
1 - 5 Sub-area Number and Boundary
BASE SOURCE: USGS 1:500,000 map sheet
1-13350
AUGUST 1978
USDA-SCS HYATTSVILLE, MD 1978

The major center of population growth is subarea 4. This subarea contains part of the Norfolk metropolitan area and is rapidly becoming urban and industrial.

Subareas 1 and 3 are predominantly rural and the population has declined. In subarea 5, change from a declining to a growing population indicates that is is reacting to economic growth along the coast. Subarea 2 is the second fastest growing area, but the growth rate is declining. During the period 1950-1960 the basins population grew slower than Virginia, North Carolina, or the U.S. as a whole. Since 1960, the basins population grew slightly faster than the state or the national rates.

Rural Farm Population

The dramatic decline in the rural farm population that has taken place during the past twenty years is shown below. This decline is shared among the 5 subareas. Each had about one-third or one-fourth of its 1950 farm population remaining in 1970.

Rural Farm Population Trends and Projections
in thousands

Subarea	1950	1960	1970	1990	2000	2020
1	58.5	34.8	19.3	8.5	6.0	3.2
2	45.9	30.7	13.3	5.9	4.0	2.1
3	56.8	36.6	13.2	5.1	3.2	1.5
4	21.9	12.2	5.1	1.9	1.2	0.6
5	9.9	5.6	3.0	1.3	0.9	0.5
Total	193.0	119.9	53.9	22.7	15.3	7.9

Source: Census of Agriculture

A large portion of the exodus from farming is due to technology. Labor is replaced on the farm by improved machinery and cropping practices. Labor is also leaving agriculture for urban employment opportunities.

Agricultural development has been accompanied by considerable social and economic adjustment in the basins. Changes in some cases have widened the already large farm income differences between subareas.

Future

Table 1 shows the past and projected population of the basins from 1950 to 2020. The basins growth is expected to continue, but at a slower rate. Subarea 1 will change from a declining population to a growing one. A similar change is expected for subarea 3, but later in the future. Subarea 5 is shown as changing from no growth to a slow rate of population increase. Subarea 4 is expected to remain the fastest growing area, but at about half the rate of the previous twenty years. Subarea 2, also a more urban area, will drop to a slower growth rate after 1990.

Table 1 Population trends and projections

Area	Historical				Projected		
	1950	1960	1970	1976	1990	2000	2020
Subarea 1 1/	102,067	99,054	96,591	91,200	103,900	106,000	108,900
Subarea 2 1/	134,053	143,390	150,113	145,700	159,700	160,400	162,000
Subarea 3 1/	98,419	94,862	87,507	87,900	87,200	88,100	91,400
Subarea 4 1/ 2/	N/A	N/A	77,700	87,500	101,700	110,700	125,600
Subarea 5 1/	30,112	29,708	30,464	33,900	31,700	32,200	33,400
VA Subtotal			276,704	272,700	311,000	320,200	334,500
NC Subtotal			165,671	173,500	173,200	177,200	186,800
Basins Total			442,375	446,200	484,200	497,400	521,300

1/ Disagregation of OBERS E projections to county level by TVA.

2/ "Chowan River-Dismal Swamp Basins, Comprehensive Water Resources Plan," Planning Bulletin 241-A, Virginia State Water Control Board, 1976.

Employment and Income

Employment in the basins has risen faster than in the rest of the country. The most rapid growth has been in the Norfolk area. The increase in jobs has mainly been in manufacturing, services, trade, and government. Agricultural employment has declined from 40 percent of the total employment in 1950 to 10 percent in 1970. Also, an increasing number of farmers have jobs off the farm. During the same period from 1950 to 1970, farmers with off-farm jobs increased from 6 percent to 34 percent.

The trend toward fewer and larger farms and increased mechanization has lowered farm employment. However, crop and timber production have increased. Also, about half the manufacturing in the basins is directly related to food, timber, or fiber production. The basins will probably continue to be largely dependent on agriculture.

Income has risen along with employment. Farm families and other families are generally still well below the income levels of both groups for the United States, but they have recently made rapid progress toward closing the gap. Farmers have also become much more independent, since tenancy has declined and almost a third of the farmers benefit from substantial off-farm employment. However, there are still large gaps in income and wealth between subregions of the basins. In some cases, these income gaps within the study area are widening.

Climate

Normal precipitation in the basins is about 48 inches per year (fig. 3). There is significant variation between the seasons. Weather patterns in the summer are influenced by tropical storms and hurricanes that develop in the Atlantic Ocean. For example, the weather station at Norfolk shows an average precipitation of only 2.7 inches in December compared with 6 inches in August. The heaviest rainfall recorded in a 24 hour period was 11.4 inches which occurred during hurricane Agnes in June 1972. Flooding sometimes accompanies this summer rainfall, but most floods occur in February and March when soils are usually quite wet, snowmelt sometimes occurs during rain storms, and vegetation is less effective in preventing runoff. The average snowfall is too small to contribute to these spring floods. A normal year has early spring rains followed by dry weather in May and June and plentiful rain later in the growing season.

The climate is hot as well as humid. Average temperatures range from 42 degrees Fahrenheit in January to 78 degrees in July. Record temperatures range from a low of -3 degrees to a high of 107 degrees. The growing season, which is the period between the last spring frost to the first frost in fall, ranges from 180 to 250 days. This long growing season with warm weather and plentiful rainfall helps make the Chowan-Pasquotank basins a productive farming area.

Geology

Physiography

The Piedmont (subarea 1) is underlain by metamorphic and igneous rocks, composed mainly of gneiss, schist, and granite. Sedimentary and igneous rocks have been changed, deformed, and intruded by magma. The resulting rock types occur in broad belts running roughly north-south (fig. 4). Weathering has produced a thick soil layer which makes it difficult to determine the relations and ages of many rock units.

The remaining subareas are in the Coastal Plain. Here the crystalline rocks of the Piedmont pass beneath layers of sediment, consisting of sand, gravel, clay, and shell beds. The soft sediments were deposited by streams and seas from the Cretaceous time to the present (approximately 100 million years). Except along streams, a thin layer of sand and gravel lies upon the older sediments.

About 9,000 years ago the Dismal Swamp began forming in subareas 4 and 5. This peat layer is a wet, sponge-like mass of decaying leaves, twigs, stumps, and fallen logs. This layer is as much as 12 feet thick and is the most recent geological formation in the basins.

Mineral Resources

Subarea 1 contains clay, slate, granite, gneiss, and sandstone. Industrial production consists of bricks, tile, and crushed stone for road construction and concrete aggregate. The other subareas contain clays, sands, gravels, sandstones, green sands, phosphate rock, shell limestone, marl, peat, and ilmenite sand. Although these minerals exist throughout the area, they are usually found in scattered deposits in thin layers.

This makes most large scale mineral industries impractical. Overall, mineral production in the Chowan-Pasquotank basins is not very significant. The supplies of clay, sand, and gravel are abundant, but the demand is limited to local construction needs. Industrial production consists mainly of cement, lime, sand, and gravel for local needs. Peat production has just recently become significant in subarea 5.

The mineral industry is expected to grow in the future, but at a slower rate than other industries. Thus, the mineral industry may never be a very important factor in the area's economy.

Groundwater

The groundwater in the Piedmont Region is confined to joints, fractures and faults in bedrock and as a result groundwater yields are low, usually less than 20 gallons per minute (gpm). Within the central portion of the basin there are several water holding layers or aquifers. The Quarternary and Tertiary aquifers, near the surface, yield moderate amounts of water, usually less than 100 gpm. The major source of ground-

NORMAL ANNUAL PRECIPITATION
(Inches)

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

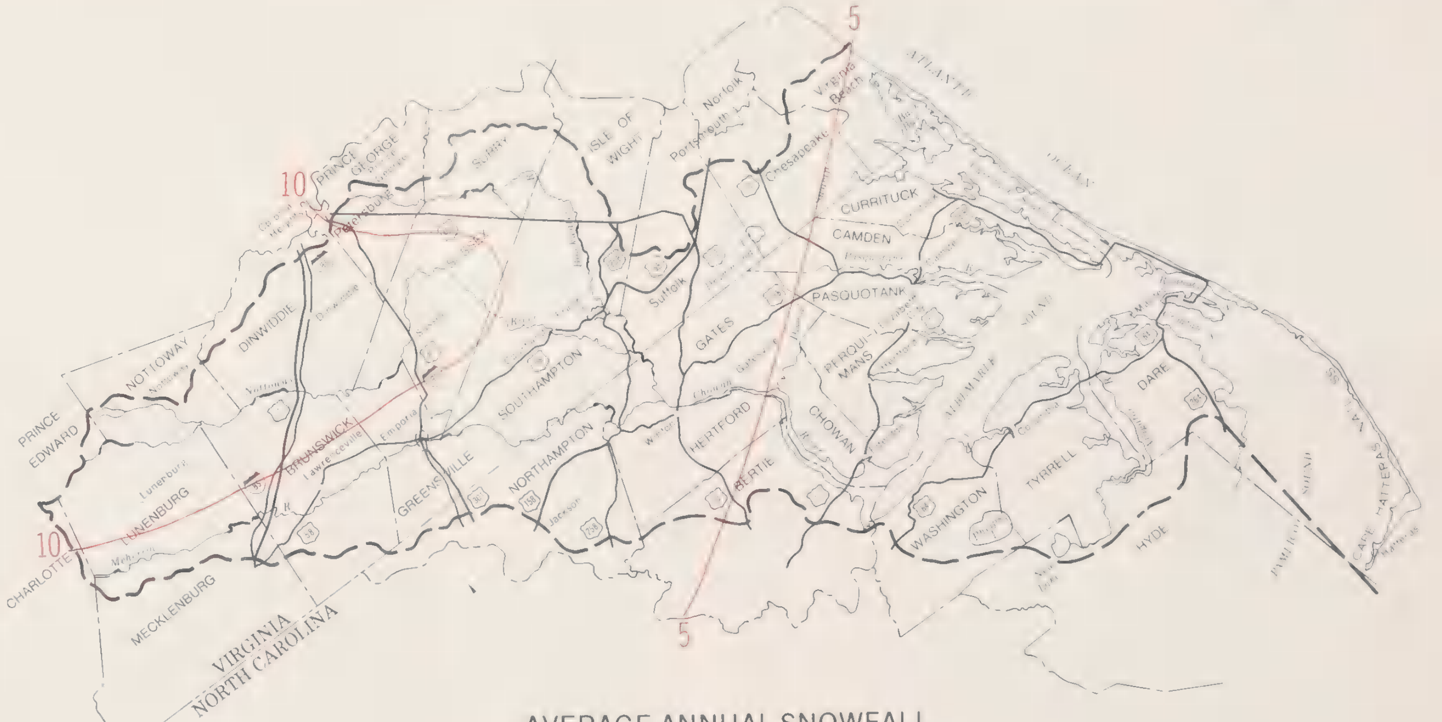
CHOWAN—PASQUOTANK RIVER BASINS

PARTS OF NORTH CAROLINA AND VIRGINIA

LEGEND

Major streams

Project boundary

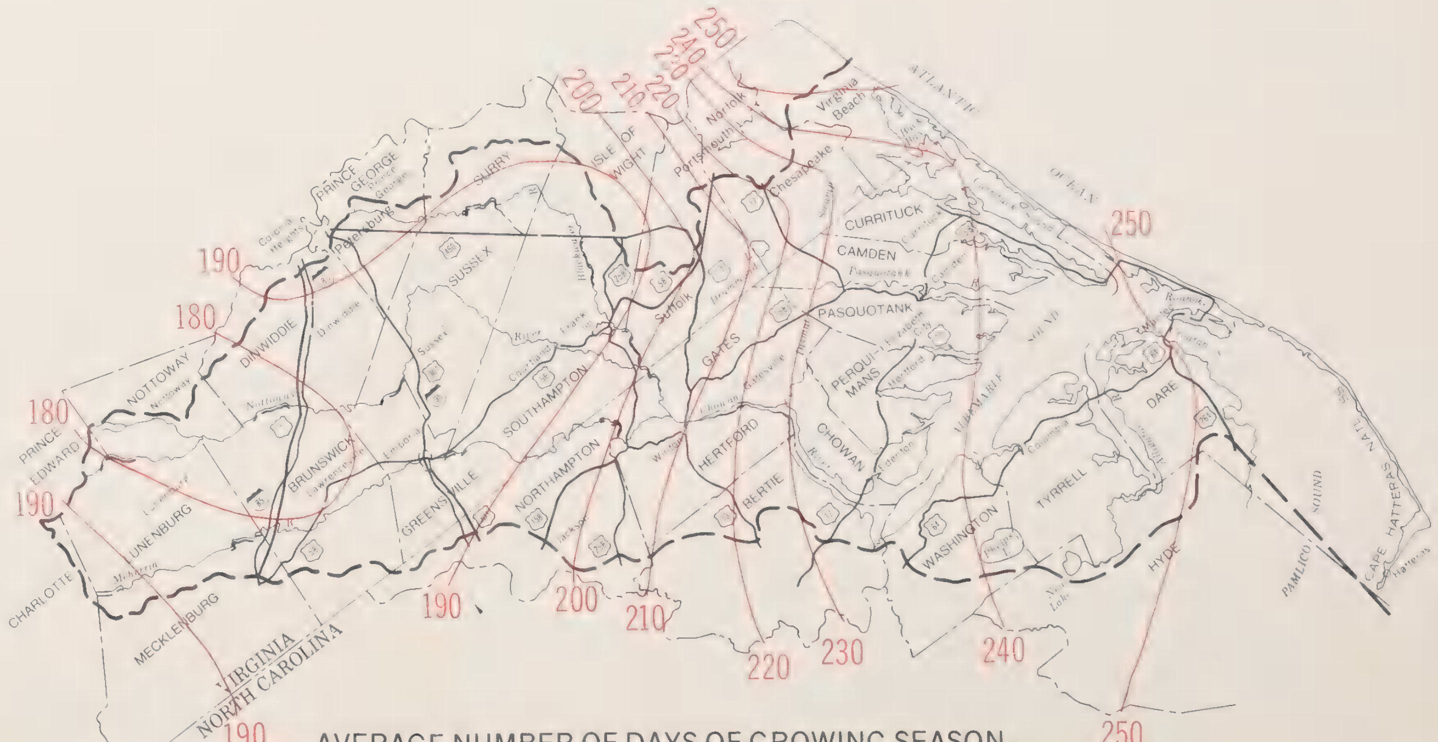


AVERAGE ANNUAL SNOWFALL
(Inches)

AVERAGE JANUARY TEMPERATURE

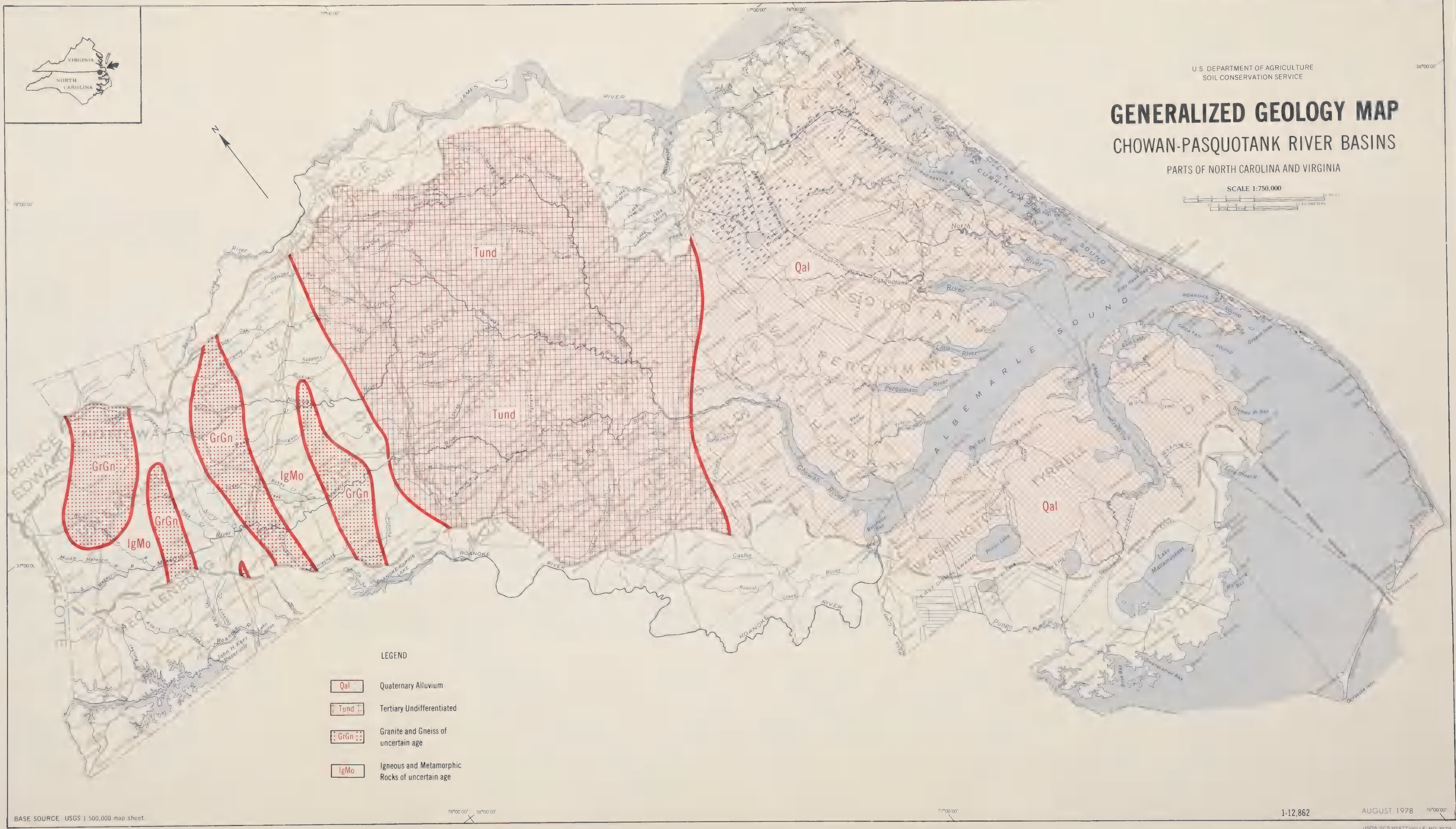
AVERAGE JULY TEMPERATURE

SEASONAL TEMPERATURES IN DEGREES FAHRENHEIT



AVERAGE NUMBER OF DAYS OF GROWING SEASON

1-13354


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
GENERALIZED GEOLOGY MAP
CHOWAN-PASQUOTANK RIVER BASINS
PARTS OF NORTH CAROLINA AND VIRGINIA
SCALE 1:750,000
VIRGINIA
NORTH CAROLINA
N
Tund
Tund
Qal
Qal
GrGn
GrGn
GrGn
GrGn
IgMo
IgMo
ALBEMARLE SOUND
CURRITUCK SOUND
Lake Mattamuskeet
LEGEND
Qal Quaternary Alluvium
Tund Tertiary Undifferentiated
GrGn Granite and Gneiss of uncertain age
IgMo Igneous and Metamorphic Rocks of uncertain age
BASE SOURCE: USGS 1:500,000 map sheet
1-12,862
AUGUST 1978
USDA-SCS HYATTSVILLE, MD 1978

water is the Lower Cretaceous aquifers which are deep sand and gravel layers. Some wells drawing from these aquifers in Southampton and Isle of Wight Counties yield over 1,000 gpm. However, these aquifers often contain large amounts of fluoride and are presently being used at or near their capacity. Within the eastern portion of the basin the Lower Cretaceous aquifers are restricted due to salt water intrusion. Wells drawing from other aquifers are generally adequate for moderate needs, but will not support additional large industrial or urban needs. There is good potential for recharge of groundwater aquifers with surface water in the Chowan-Pasquotank basins but this has not been attempted to date.

Soil Associations

The general soils map (figure 5) shows the soil associations in the basins. A soil association is a distinctive pattern of soils found in combination. It normally consists of one or more major soils and at least one minor soil, and is named for the major soils.

The general soils map provides a broad perspective of the soils within the basins. It provides a basis for comparing large areas for general kinds of land use. It does not show the kind of soil at a specific site.

The map shows soil associations and the three major land resource areas of the river basins. These areas are the Southern Piedmont, the Southern Coastal Plain, and the Atlantic Coast Flatwood region.

The Piedmont occupies the western part of the basins, which includes most of subarea 1, and consists of seven soil associations. The soils for the most part are weathered from metamorphic and igneous rocks. Appling, Cecil, Goldston, Vance, Georgeville, Herndon, Madison, Fluvanna, Cullen, and Weedowee are well drained soils. The other major soils are not as well drained.

Usually the well drained soils on mild slopes are used for the production of corn, tobacco, and small grain. Soils occupying steep slopes, or those that are poorly drained, are usually used for pasture and forest.

The Coastal Plain occupies the central part of the basins and includes most of subareas 2 and 3. It consists of 16 soil associations that have been formed from marine and alluvial sediments. The dominant well drained soils in the coastal plain include Norfolk, Kenansville, Suffolk, Masada, Pamunkey, Alaga, and Wickham. Most of the soils in the area have a seasonally high water table and need drainage to achieve the best crop yields.

The moderate to well drained soils are used for peanuts, corn, soybeans, small grain, and similar crops. Most of the poorly drained soils are used for pasture or forest. Many of these poorly drained soils are being changed through artificial drainage. Much of the change in land use is pasture and forest land being converted to cropland or non-agricultural uses.

The Atlantic Flatwood region occupies the eastern part of the basins and includes most of subareas 4 and 5. It consists of 19 soil associations, most of which have a seasonably high water table. There are only a few well drained soils in the region, consisting of Alaga, Pamunkey, State, Newham, and Lakeland. Drainage is necessary for economic crop production and is being done on a large part of the land. Soils that are naturally well drained and those with artificial drainage are generally used for corn, soybeans, peanuts, small grain, and truck crops. Most of the poorly drained soils are in forest and pasture.

Table 2 gives a general description of the limitations for the various soil associations. The limitations are given for septic tanks, sanitary landfills and general agriculture. A limitation, such as severe, is a general rating for the soil associations. Some areas of the same association may have less restrictive limitations. The agricultural limitations are also general in nature. For instance, the Appling-Cecil association is erosive, but on a gentle slope or properly managed, it is an excellent soil for growing crops.

For economic analyses, the soils were combined into soil productivity groups (SPG's). An SPG is a group of soils with similar potential for crop production, similar potential for erosion, and similar management needs. These groups are used to analyze the economic effects of conservation treatment. Detailed descriptions of soil productivity groups may be found in the technical appendix.

Prime Land

Prime Farmland

Prime farmland is land that has the best combination of physical and chemical characteristics for producing food, feed, storage, fiber, and oilseed crops, and is also available for these. Soils which are excessively wet under natural condition may become prime farmland with an effective drainage system.

Only about a fourth to a third of the prime farmland is being used for crop production. Some areas of prime farm soils will probably never be used for crop production because they occur in areas too small for economic farming or are already committed to higher valued uses.

The amount of highly productive farmland has increased since 1967, due to drainage of wetlands. This is particularly true in subareas 4 and 5. The increase in productive land due to drainage is probably much greater than the loss due to residential development thus far. However, there is a limit to the amount of farmland that can be created.

Figure 6 gives a general idea of the location of the prime farmland. The river bottoms have less prime land because they are generally swampy. The majority of the prime land is in small plots on the gentler slopes of the uplands.

SOIL ASSOCIATIONS

LEGEND

A Southern Piedmont - A region of gently rolling to hilly slopes with narrow stream valleys. Local relief is mainly in tens of feet to several tens of feet.

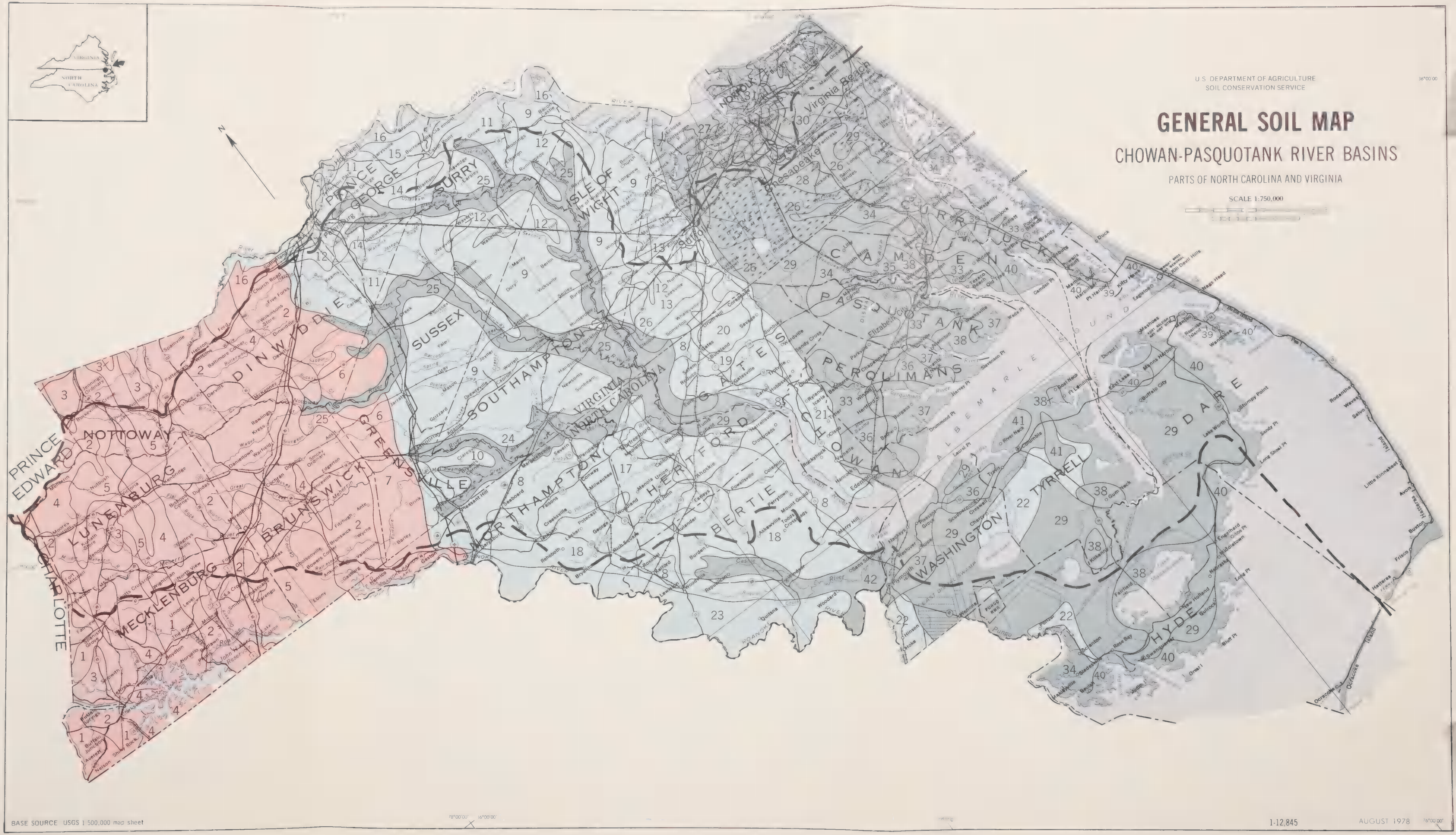
1 Orange-Helena-Goldston
2 Appling-Cecil
3 Iredell-Helena-Vance
4 Georgeville-Herndon-Goldston
5 Cecil-Appling-Madison
6 Fluvanna-Gritney-Cullen
7 Gritney-Fluvanna-Wedowee

B Southern Coastal Plain - A region of gently sloping uplands and broad meandering stream bottoms on the eastern boundary changing to strongly sloping uplands and narrower stream bottoms on the western boundary. Elevations are generally above twenty-five feet and local relief is mainly in a few tens of feet.

8 Norfolk-Goldsboro
9 Goldsboro-Ogeechee-Emporia
10 Aquults-Craven-Altavista
11 Emporia-Tetotum-Bourne
12 Bayou-Myatt-Lynchburg
13 Eunola-Kenansville-Suffolk
14 Atlee-Craven-Lenoir
15 Angie-Aquults-Masada
16 Pamunkey-Altavista-Fluvaquents
17 Aycock-Marlboro
18 Lenoir-Craven-Coxville
19 Craven-Leaf-Lenoir
20 Lenoir-Leaf
21 Lakeland-Bertie-Dragston
22 Bladen-Bayboro
23 Wickham-Altavista

C Atlantic Coast Flatwoods - A region of nearly level coastal plain cut by broad meandering streams which generally end in estuaries along the coast. Elevations are generally below twenty-five feet and local relief is mainly a few feet to ten or twenty feet.

24 Fluvaquents-Altavista
25 Pactolus-Alaga-Fluvaquents
26 Lumbee-Dragston-Johns
27 Johns-Pamunkey-Tetotum
28 Torhunta-Deloss
29 Ponzer-Pamlico-Dorovan
30 Aquepts-State-Altavista
31 Sulfaquents-Hydraquents-Pungo
32 Newhan-Duckston-Corolla
33 Bertie-Woodington
34 Bladen-Lenoir-Hyde
35 Wehadkee-Roanoke
36 Bladen-Lenoir
37 Craven-Marlboro-Bladen
38 Weeksville-Pasquotank
39 Lakeland-Pactolus
40 Capers-Newhan
41 Hyde-Pocomoke-Rutledge
42 Chewacla-Wehadkee



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SOIL ASSOCIATIONS
LEGEND

A Southern Piedmont - A region of gently rolling to hilly slopes with narrow stream valleys. Local relief is mainly in tens of feet to several tens of feet

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2 Appling-Cecil
3 Iredell-Helena-Vance
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6 Fluvanna-Gritney-Cullen
7 Gritney-Fluvanna-Wedowee

B Southern Coastal Plain - A region of gently sloping uplands and broad meandering stream bottoms on the eastern boundary, changing to strongly sloping uplands and narrower stream bottoms on the western boundary. Elevations are generally above twenty-five feet and local relief is mainly in a few tens of feet

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13 Eunola-Kenansville-Suffolk
14 Atlee-Craven-Lenoir
15 Angie-Aquults-Masada
16 Pamunkey-Altavista-Fluvaquents
17 Aycock-Marlboro
18 Lenoir-Craven-Coxville
19 Craven-Leaf-Lenoir
20 Lenoir-Leaf
21 Lakeland-Bertie-Dragston
22 Bladen-Bayboro
23 Wickham-Altavista

C Atlantic Coast Flatwoods - A region of nearly level coastal plain cut by broad meandering streams which generally end in estuaries along the coast. Elevations are generally below twenty-five feet and local relief is mainly a few feet to ten or twenty feet.

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25 Pactolus-Alaga-Fluvaquents
26 Lumbee-Dragston-Johns
27 Johns-Pamunkey-Tetotum
28 Torhunta-Deloss
29 Ponzer-Pamlico-Dorovan
30 Aquepts-State-Altavista
31 Sulfaquents-Hydraquents-Pungo
32 Newhan-Duckston-Corolla
33 Bertie-Woodington
34 Bladen-Lenoir-Hyde
35 Wehadkee-Roanoke
36 Bladen-Lenoir
37 Craven-Marlboro-Bladen
38 Weeksville-Pasquotank
39 Lakeland-Pactolus
40 Capers-Newhan
41 Hyde-Pocomoke-Rutledge
42 Chewacla-Wehadkee

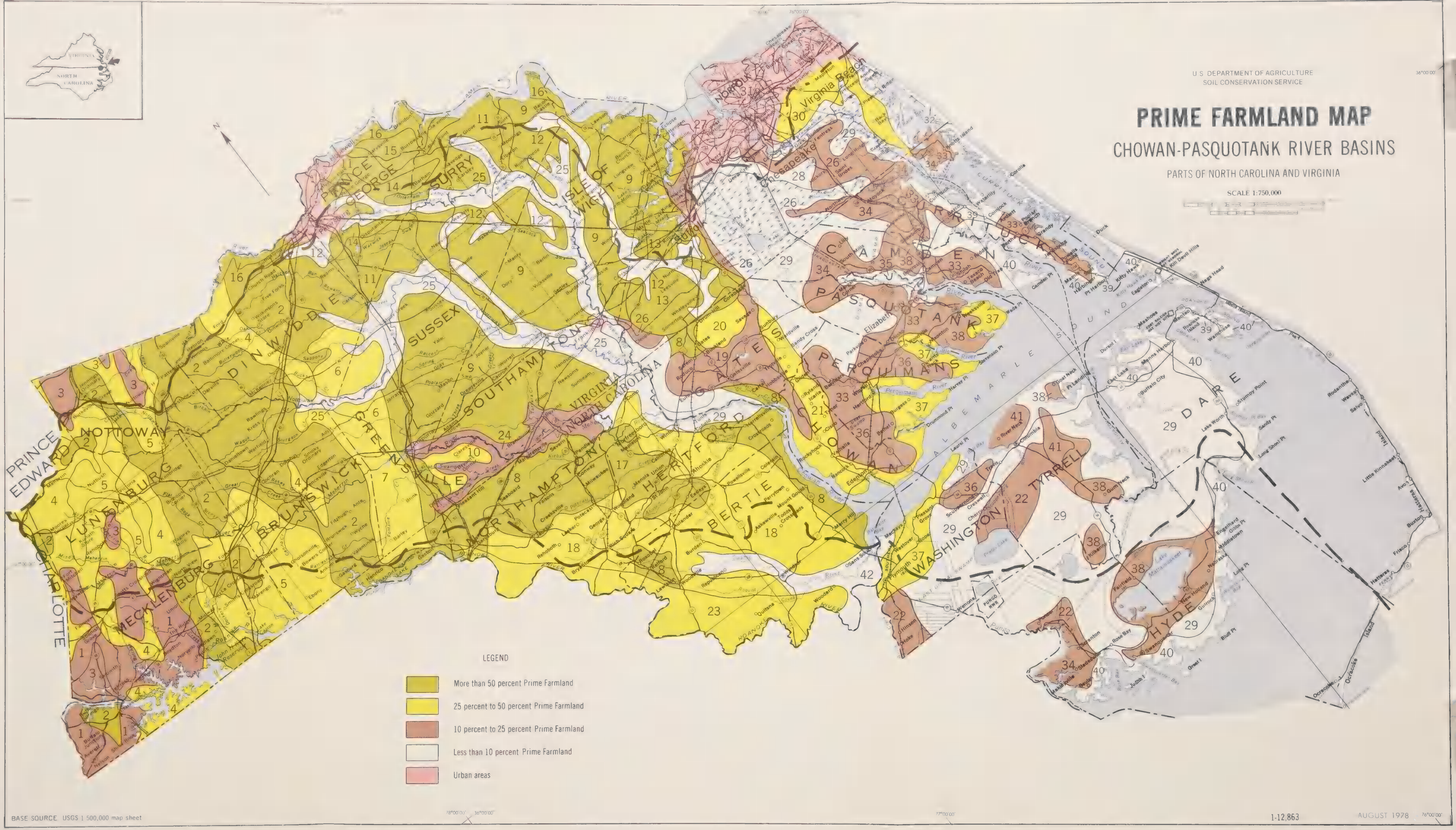

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Table 2 Soil limitations for major soils

Map Index	Sub-area	Association Name	Soil Limitations: Septic Tank	Sanitary Landfill: Trench	Sanitary Landfill: Area	Agriculture
1	1	Orange-Helena-Goldston	Severe	Severe	Moderate	Seasonal wetness
2	1	Appling-Cecil	Moderate	Moderate	Slight	Erosion hazard
3	1	Iredell-Helena-Vance	Severe	Severe	Moderate	Seasonal wetness
4	1	Georgeville-Herndon-Goldston	Moderate	Moderate	Moderate	Erosion hazard
5	1	Cecil-Appling-Madison	Moderate	Moderate	Slight	Erosion hazard
6	1 & 2	Fluvanna-Gritney-Cullen	Severe	Severe	Slight	Erosion hazard
7	2	Gritney-Fluvanna-Wedowee	Severe	Severe	Moderate	Erosion hazard
8	2 & 3	Norfolk-Goldsboro	Moderate	Moderate	Moderate	Wetness or erosion
9	2	Goldsboro-Ogeechee-Emporia	Severe	Severe	Severe	Wetness or erosion
10	2	Aquults-Craven-Altavista	Severe	Severe	Severe	Wetness or erosion
11	1 & 2	Emporia-Tetotum-Bourne	Severe	Severe	Severe	Wetness or erosion
12	1 & 2	Bayou-Myatt-Lynchburg	Severe	Severe	Severe	Wetness or flooding
13	2	Eunola-Kenansville-Suffolk	Moderate	Severe	Severe	Wetness or erosion
14	2	Atlee-Craven-Lenoir	Severe	Severe	Severe	Wetness or flooding
16	1	Pamunkey-Altavista-Fluvaquents	Moderate	Severe	Moderate	Wetness or flooding
17	3	Aycock-Marlboro	Moderate	Slight	Slight	Wetness or erosion

Table 2 Soil limitations for major soils - Continued

Map Index	Sub-area	Association Name	Soil Limitations: Septic Tank	Sanitary Landfill: Trench	Sanitary Landfill: Area	Agriculture
18	3	Lenoir-Craven-Coxville	Severe	Severe	Severe	Wetness or flooding
19	3	Craven-Leaf-Lenoir	Severe	Severe	Severe	Wetness or flooding
20	3	Lenoir-Leaf	Severe	Severe	Severe	Wetness or flooding
21	3	Lakeland-Bertie-Dragston	Moderate	Severe	Severe	Droughty
22	5	Bladen-Bayboro	Severe	Severe	Severe	Wetness or flooding
24	2 & 3	Fluvaquents-Altavista	Severe	Severe	Severe	Flooding
25	1,2 & 3	Pactolus-Alaga-Fluvaquents	Moderate	Severe	Severe	High water table
26	2 & 4	Lumbee-Dragston-Johns	Severe	Severe	Severe	Wetness or flooding
28	4	Torhunta-Deloss	Severe	Severe	Severe	Wetness or flooding
29	3,4 & 5	Ponzer-Pamlico-Dorovan	Severe	Severe	Severe	Poorly drained
30	4	Aquepts-State-Altavista	Moderate	Severe	Severe	Wetness
31	4	Sulfaquents-Hydraquents-Pungo	Severe	Severe	Severe	High sulfur content
32	4	Newhan-Duckston-Corolla	Severe	Severe	Severe	Beach sands
33	4	Bertie-Woodington	Severe	Severe	Severe	Wetness of flooding
34	4	Bladen-Lenoir-Hyde	Severe	Severe	Severe	Wetness or flooding
35	4	Wehadkee-Roanoke	Severe	Severe	Severe	Flooding

Table 2 Soil limitations for major soils - Continued

Map Index	Sub-area	Association Name	Soil Limitations: Septic Tank	Soil Limitations: Sanitary Landfill Trench	Soil Limitations: Sanitary Landfill Area	Soil Limitations: Agriculture
36	3,4 & 5	Bladen-Lenoir	Severe	Severe	Severe	Wetness or flooding
37	4 & 5	Craven-Marlboro-Bladen	Severe	Severe	Moderate	Wetness or flooding
38	4 & 5	Weeksville-Pasquotank	Severe	Severe	Severe	Wetness or flooding
39	4 & 5	Lakeland-Pactolus	Moderate	Severe	Severe	Droughty
40	5	Capers-Newhan	Severe	Severe	Severe	High sulfur content
41	5	Hyde-Pocomoke-Rutledge	Severe	Severe	Severe	Wetness or flooding

Prime Timberland

Prime timberland is land that has soil capable of growing wood at the rate of 85-cubic feet or more/acre/year culmination of mean annual increment in natural stands and is not in urban or built-up land uses or water. Of the existing commercial forest land, 16 percent or 639,000 acres will probably qualify as prime timberland. Over 60 percent of this acreage is in subareas 2 and 3.

About six percent of prime timberland has been converted to other uses in the past 10 years. This loss of prime timberland is not projected to have a significant effect on timber production by the year 2020. However, the projections do not account for the potential increase in firewood demand.

Land Use

Present

In 1976, urban areas, water areas, and federal lands made up about 20 percent of the total area in the basins. The remainder was used for agriculture and consisted of forest land (55 percent), cropland (19 percent), pastureland (2 percent), and other land (4 percent). (Fig. 7)

The forest acreage is about one-third softwoods and two-thirds hardwoods. However, about half the total volume of standing timber is softwoods. Most of the softwood acres are owned by forest industries or farmers. These acres are highly managed for timber production. Wetlands and other idle lands are generally covered with hardwoods and are mostly owned by farmers. The low growth rate, harvesting difficulties, and the low price paid for hardwood by timber companies give these lands little commercial timber value.

The major crops in subarea 1 are soybeans, wheat, and corn. Although tobacco has traditionally been an important crop, the acreage has decreased slightly while other crops have increased. In the other subareas peanuts, soybeans, and corn are the major crops. Some sorghum and hay are grown throughout the basins, and truck crops are significant in subareas 4 and 5. Livestock production particularly hogs, is important in subareas 1 and 2. An increasing number of acres are producing two crops a year, and soybean acreage is increasing dramatically.

Future

Table 3 shows the past and projected future land uses for each subarea, without changes in existing programs. Many acres of wetland forest have been cleared, drained, and converted to cropland. This trend is particularly noticeable in subarea 5 where several large corporate farms operate. This trend is projected to continue in the future. The cropland figures for Virginia show a slight decrease, reflecting urbanization, increased park land, and erosion problems. Cropped acres are increasing in subareas 4 and 5, where soybeans are the major crop.


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
AND
FOREST SERVICE
MAJOR LAND USES
CHOWAN-PASQUOTANK RIVER BASINS
PARTS OF NORTH CAROLINA AND VIRGINIA
SCALE 1:750,000
VIRGINIA
NORTH
CAROLINA
N
1
2
3
4
5
NOTTOWAY
PRINCE EDWARD
LUNENBURG
BRUNSWICK
MECKLENBURG
SUSSEX
SOUTHAMPTON
GREENSVILLE
SURRY
ISLE OF WIGHT
PRINCE GEORGE
HERTFORD
GATES
NORTHAMPTON
BERTIE
CHOWAN
PERQUIMANS
PASQUOTANK
CAMDEN
CURRITUCK
WASHINGTON
TYRRELL
DARE
HYDE
LEGEND
Crop, pasture, and other agricultural land
Forestland
Urban land
1 - 5 Sub-area Number and Boundary
Forestland location prepared by USDA Forest Service
BASE SOURCE: USGS 1:500,000 map sheet
JUNE 1979
1-14,509
USDA SCS HYATTSVILLE MD 1979

Table 3 Land use trends and projected future without plan conditions

Land use	1958	Historical 1967	1976	1990	Projected 2000	2020
			Acres			
Subarea 1						
Non-agricultural	50,010	55,440	62,650	69,550	77,065	94,235
Cropland	167,330	166,940	158,125	165,260	157,745	144,870
Pastureland	50,350	45,575	33,970	42,925	40,780	37,555
Forest land	780.125	784,075	801,455	782,290	786,580	787,655
Other rural 1/	26,160	21,945	17,775	13,950	11,805	9,660
Subtotal - 1,073,975						
Subarea 2						
Non-agricultural	34,675	41,325	77,750	80,195	81,545	84,250
Cropland	327,925	321,650	322,100	319,085	315,030	308,270
Pastureland	34,900	33,825	22,800	31,095	29,745	27,040
Forest land	921,750	925,525	909,850	892,355	897,760	907,225
Other rural	34,575	31,500	21,325	31,095	29,745	27,040
Subtotal - 1,353,825						
Subarea 3						
Non-agricultural	58,380	67,425	75,905	78,865	87,135	105,505
Cropland	262,525	253,775	232,125	234,235	230,555	222,290
Pastureland	20,925	16,925	13,900	9,185	7,350	4,595
Forest land	597,670	587,710	593,725	586,955	573,175	535,510
Other rural	24,850	38,515	48,695	55,110	66,135	96,450
Subtotal - 964,350						
Subarea 4						
Non-agricultural	336,600	350,575	357,825	393,755	411,225	450,055
Cropland	294,925	337,475	334,975	343,630	367,895	410,605
Pastureland	29,275	21,575	15,125	9,705	6,795	3,885
Forest land	547,750	505,575	478,575	447,490	407,695	331,010
Other rural	66,600	59,950	88,650	80,570	81,540	79,595
Subtotal - 1,275,150						

1/ Other rural land consists of farmsteads, farm roads, barn and feed lots, idle land, stripmines, borrow areas, marshes, dunes, etc.

Table 3 Land use trends and projected future without plan conditions - Continued

Land use	Historical 1958	1967	1976	Projected 1990	2000	2020
			Acres			
Subarea 5						
Non-agricultural	601,425	623,150	627,325	630,355	636,655	651,355
Cropland	65,000	76,025	94,300	117,610	137,210	180,615
Pastureland	3,850	5,825	4,300	4,900	7,000	9,800
Forest land	530,050	511,425	486,825	459,930	429,830	365,425
Other rural	78,275	62,175	65,850	65,805	67,905	71,405
Subtotal - 1,278,600						
Virginia						
Non-agricultural	138,060	150,790	196,825	221,415	237,005	271,375
Cropland	612,655	638,515	605,550	610,280	605,350	597,625
Pastureland	98,875	91,575	65,845	80,495	75,340	67,675
Forest land	1,860,025	1,856,825	1,855,455	1,814,295	1,814,275	1,805,640
Other rural	108,235	80,145	94k175	91,365	85,880	75,535
Subtotal - 2,817,850						
North Carolina						
Non-agricultural	943,030	987,125	1,004,630	1,031,305	1,056,620	1,114,025
Cropland	505,050	517,350	536,075	569,540	603,085	669,025
Pastureland	40,425	32,150	24,250	17,315	16,330	15,200
Forest land	1,517,320	1,457,485	1,414,975	1,354,725	1,280,765	1,121,185
Other rural	122,225	133,940	148,120	155,165	171,250	208,615
Subtotal - 3,128,050						
Total study area						
Non-agricultural	1,081,090	1,137,915	1,201,455	1,252,720	1,293,625	1,385,400
Cropland	1,117,705	1,155,865	1,141,625	1,179,820	1,208,435	1,266,650
Pastureland	139,300	123,725	90,095	97,810	91,670	82,875
Forest land	3,377,345	3,314,310	3,270,430	3,169,020	3,095,040	2,926,825
Other rural	230,460	214,085	242,295	246,530	257,130	284,150
Total area - 5,945,900						

The decrease in forests largely reflects land clearing operations on wet soils. The forest land that is being lost is generally the less productive forest land, but some of the more important wildlife habitat. After drainage this land has become productive cropland. The land is suitable for future timber operations, but timber is usually not as profitable as crop production. Projections were not made on the ratio of softwood to hardwood, but past trends indicate that softwood acres are decreasing.

Figure 8 shows the forest cover types in 1955. It shows a large majority of softwoods in the basins. Present estimates show only about a third of the forests are softwoods. This illustrates the dramatic decrease in softwood acres.

Pastureland is decreasing rather rapidly. This is due partially to a shift from year round pasture to a hay and pasture rotation. Land in rotation between hay and pasture is reported as cropland in this inventory. Also, there is a strong trend toward all season feedlot operations, decreasing the need for pasture.

The rise in non-inventory acres is due in part to the growth of the Norfolk and Petersburg urban areas. A much larger part of this increase has been due to the growth of recreation and wildlife areas. Several state parks have been developed and the Dismal Swamp National Wildlife Refuge has enlarged due to land donations.

Land Treatment

Present

Land treatment refers to continuing programs designed to maintain or improve the land. A land treatment program can be applied to solve erosion, drainage or productivity problems. Land is considered to be adequately treated when used and treated in such a way as to maintain soil depth, texture, tilth, and fertility with good management of crops or forest while avoiding most damages to air or water quality.

About 33 percent of the cropland in the basins was considered adequately treated in 1976. Forty-one percent of the pastureland, 48 percent of the forest land, and 62 percent of the other land was adequately treated. Treatment programs on cropland usually involve erosion prevention or drainage. Pastureland treatment is usually for erosion prevention or prevention of overgrazing. Forest land treatment usually deals with timber stand improvement or reforestation. Treatment programs also consider whether the land is suited for its present use.

Conservation planning is a service provided through soil conservation districts. The plans outline a program of land use and land treatment based on the individual owner's decisions for managing and conserving soil, water, and plant resources. At present, conservation plans have been requested for only 30 percent of the agricultural land in the basins. Appendix tables 4A - 8A show the status of land treatment for each county in 1967 and 1976.

Future

Table 4 shows the projected progress in land treatment under existing programs. Adequately treated cropland is expected to increase at a fairly slow rate. It may take several years to recover the initial costs of land treatment even though government agencies provide part of these funds. The land treatment practices needed change as agricultural practices change. Some treatment measures deteriorate and require replacement. Also, there are often economic pressures that encourage farming of marginal land and discourage conservation planning. These factors contribute to the slow progress in treatment of cropland. If these economic pressures increase, the amount of adequately treated cropland may actually decrease. Pastureland figures show a tremendous increase in percent adequately treated, while total acreage is decreasing. Most pasture being converted to other uses is poorly treated land; this raises the percent of adequately treated pasture. This is best illustrated by the projections for subarea 3.

A similar situation is occurring with the forest land, although not as dramatic. The increasing demand for firewood can aid in forest management programs if the poorer quality trees are cut for firewood. At present, firewood accounts for about a fourth of the hardwood cut in Virginia.

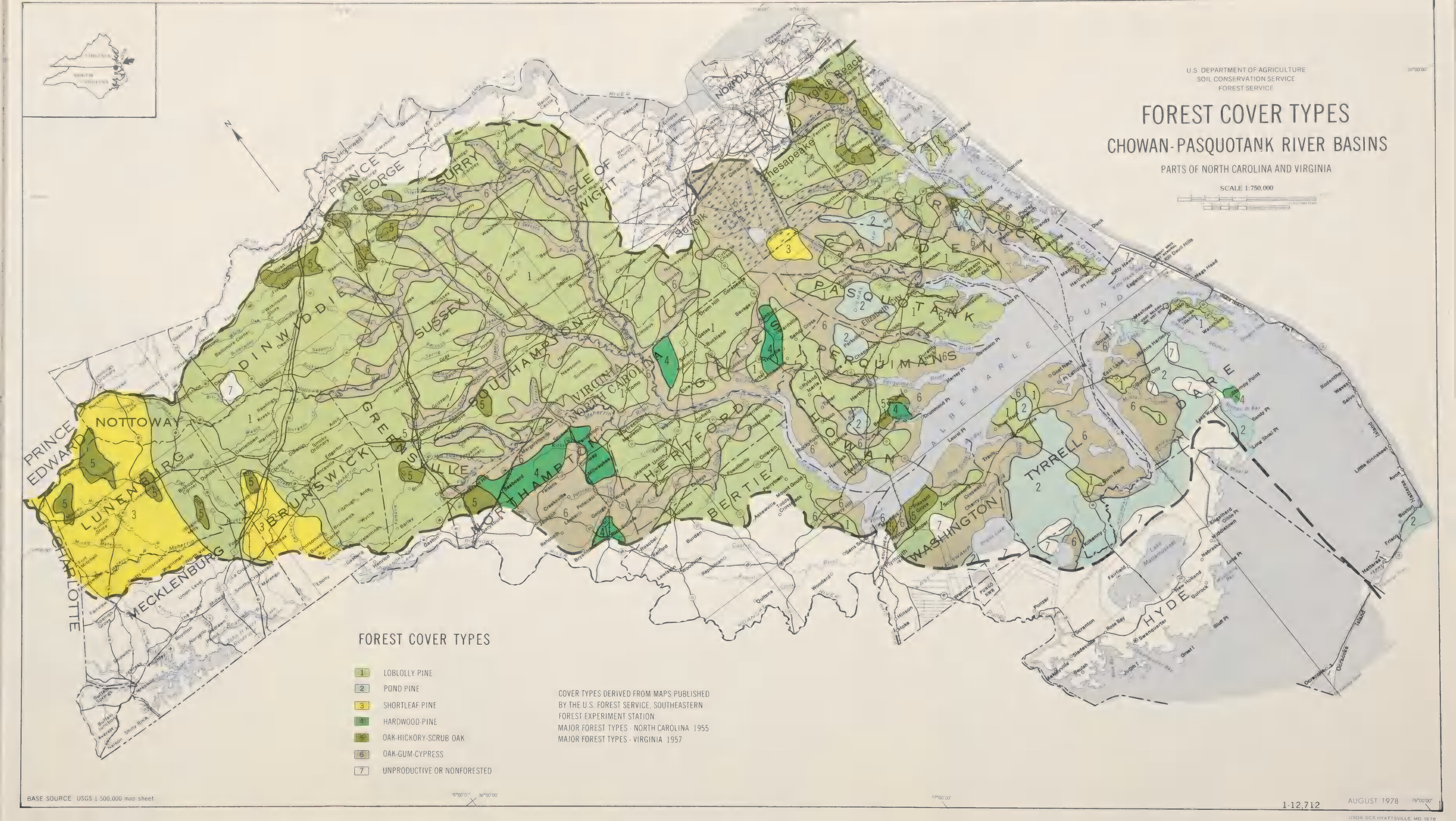
Water Resources

Specific Water Surface Areas

The western fifth of the Chowan-Pasquotank basins is mostly hilly terrain that confines the streams to narrow channels. There are no large bodies of water, but there are several small reservoirs used for water supply. Within the central part of the basins the land becomes flatter, and the three major rivers (the Blackwater, Nottoway, and Meherrin) occupy broad, swampy channels. These river marshes are the only major fresh water surface areas within this region. The eastern portion of the Chowan-Pasquotank has more water than dry land.

A large part of the area is covered by the Dismal Swamp and other marsh land and natural lakes influenced by surface and groundwater flow such as Lake Drummond, Phelps Lake and New Lake. There are also wide tidal rivers such as the Chowan, Pasquotank, and Alligator Rivers and large salt water areas such as Albemarle Sound, Currituck Sound, and Croatan Sound.

There are several existing reservoirs within the Chowan-Pasquotank basin (fig. 9), but most are small water supply reservoirs in the Piedmont Region where groundwater is scarce. There are several additional reservoir sites in the Piedmont area that could be studied in the future for water supply and flood control. Within the central portion of the basin several sites have been studied but usually have not been built due to economic considerations. Any large reservoirs in the eastern portions of the basins would have to be quite shallow and would inundate some wetland areas.


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
FOREST SERVICE
FOREST COVER TYPES
CHOWAN-PASQUOTANK RIVER BASINS
PARTS OF NORTH CAROLINA AND VIRGINIA
SCALE 1:750,000
FOREST COVER TYPES
1 LOBLOLLY PINE
2 POND PINE
3 SHORTLEAF PINE
4 HARDWOOD-PINE
5 OAK-HICKORY-SCRUB OAK
6 OAK-GUM-CYPRESS
7 UNPRODUCTIVE OR NONFORESTED
COVER TYPES DERIVED FROM MAPS PUBLISHED
BY THE U.S. FOREST SERVICE, SOUTHEASTERN
FOREST EXPERIMENT STATION
MAJOR FOREST TYPES - NORTH CAROLINA 1955
MAJOR FOREST TYPES - VIRGINIA 1957
BASE SOURCE USGS 1:500,000 map sheet
1-12,712
AUGUST 1978
USDA-SCS HYATTSVILLE MD 1978
VIRGINIA
NORTH CAROLINA
PRINCE EDWARD
NOTTOWAY
LUNENBURG
CHARLOTTE
MECKLENBURG
BRUNSWICK
DINWIDDIE
PRINCE GEORGE
SURRY
SUSSEX
GREENSVILLE
SOUTHAMPTON
ISLE OF WIGHT
NORTHAMPTON
HERTFORD
GATES
BERTIE
CHOWAN
PERQUIMANS
PASQUOTANK
CAMDEN
CURRITUCK
WASHINGTON
TYRRELL
DARE
HYDE
ALBEMARLE SOUND
Chesapeake
Suffolk
Norfolk
Virginia Beach

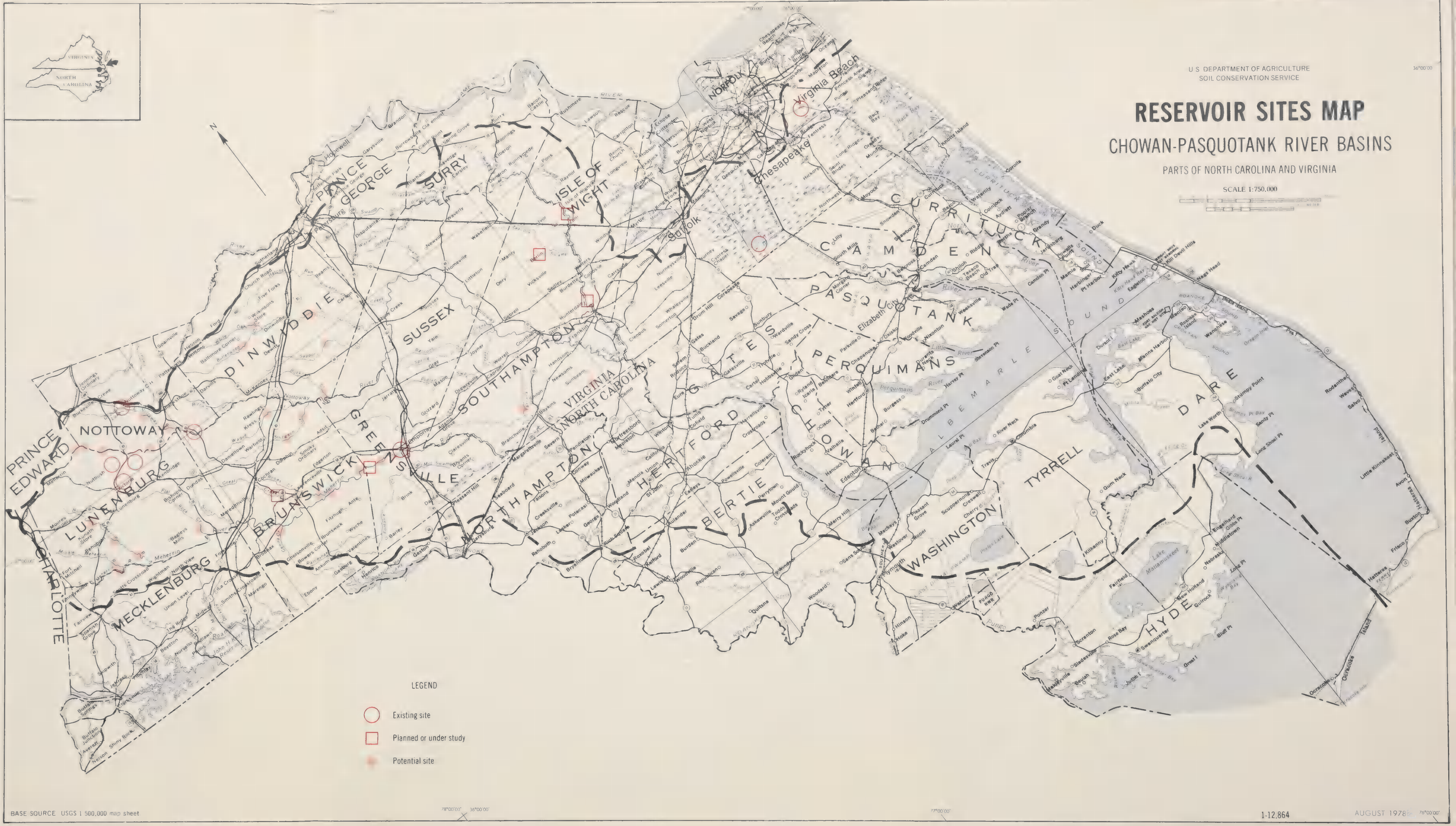

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
RESERVOIR SITES MAP
CHOWAN-PASQUOTANK RIVER BASINS
PARTS OF NORTH CAROLINA AND VIRGINIA
SCALE 1:750,000
VIRGINIA
NORTH CAROLINA
N
PRINCE GEORGE
SURRY
ISLE OF WIGHT
NORFOLK
Virginia Beach
Chesapeake
Suffolk
DINWIDDIE
SUSSEX
SOUTHAMPTON
NOTTOWAY
PRINCE EDWARD
LUNENBURG
BRUNSWICK
GREENSVILLE
MECKLENBURG
CHARLOTTE
NORTHAMPTON
HERTFORD
GATES
BERTIE
CHOWAN
PERQUIMANS
PASQUOTANK
CAMDEN
CURRITUCK
DARE
TYRRELL
WASHINGTON
HYDE
ALBEMARLE SOUND
LEGEND
Existing site
Planned or under study
Potential site
BASE SOURCE USGS 1:500,000 map sheet
1-12,864
AUGUST 1978

Table 4 Projections of land treatment without plan conditions

Subarea and Land Use	1976		1990		2000		2020	
	Acres Adequately Treated (And Percent of Total Area)							
Subarea 1								
Cropland	47,885	(30%)	56,518	(34%)	57,418	(36%)	57,948	(40%)
Pastureland	13,600	(40%)	26,528	(62%)	32,828	(81%)	34,175	(91%)
Forest land	433,370	(54%)	493,624	(63%)	531,728	(68%)	597,830	(76%)
Other agric.	12,745	(72%)	9,542	(68%)	7,992	(68%)	6,665	(69%)
Subarea 2								
Cropland	135,395	(42%)	146,778	(46%)	151,214	(48%)	156,909	(51%)
Pastureland	7,925	(35%)	13,495	(43%)	15,378	(52%)	16,467	(61%)
Forest land	479,275	(53%)	443,500	(50%)	383,344	(43%)	395,550	(44%)
Other agric.	14,820	(69%)	21,580	(69%)	20,792	(70%)	19,630	(73%)
Subarea 3								
Cropland	51,725	(22%)	71,442	(31%)	79,772	(35%)	93,362	(42%)
Pastureland	7,300	(53%)	7,642	(83%)	6,872	(93%)	4,550	(99%)
Forest land	234,665	(40%)	359,216	(61%)	413,832	(72%)	464,823	(87%)
Other agric.	28,145	(58%)	36,428	(66%)	45,699	(69%)	72,144	(75%)
Subarea 4								
Cropland	113,575	(34%)	127,143	(37%)	142,006	(39%)	168,758	(41%)
Pastureland	7,420	(49%)	5,910	(61%)	4,797	(71%)	3,135	(81%)
Forest land	229,735	(48%)	319,955	(71%)	339,202	(83%)	305,190	(92%)
Other agric.	51,500	(58%)	24,734	(31%)	28,946	(35%)	40,275	(51%)
Subarea 5								
Cropland	29,165	(31%)	40,575	(34%)	49,670	(36%)	69,898	(39%)
Pastureland	875	(20%)	1,588	(32%)	3,192	(46%)	6,105	(62%)
Forest land	194,815	(40%)	298,954	(65%)	314,636	(73%)	317,188	(87%)
Other agric.	43,100	(65%)	53,038	(81%)	56,836	(84%)	60,980	(85%)

Table 4 Projections of land treatment without plan conditions - Continued

Subarea and Land Use	1976		1990		2000		2020	
	Acres Adequately Treated (And Percent of Total Area)							
Total Study Area								
Cropland	377,745	(33%)	431,814	(37%)	473	(39%)	548,458	(43%)
Pastureland	37,120	(41%)	54,774	(56%)	60,502	(66%)	67,212	(81%)
Forest land	1,571,860	(48%)	1,933,102	(61%)	2,024,156	(65%)	2,130,827	(72%)
Other agric.	150,310	(62%)	170,352	(69%)	187,448	(73%)	223,910	(79%)

The major lakes are in the flat coastal area and are maintained by groundwater seepage. The major feature of the eastern portion of the Chowan-Pasquotank basin is the extensive wetland area. Estimates of the wetland area in this region range as high as 2,000 square miles. These wetlands are large natural reservoirs with a forest cover that decreases evaporation loss. The potential evaporation rate is about 40 inches per year. These wetlands are an integral part of the surface and groundwater hydrology of the region.

Present Water Supply

Average water withdrawals through the year are about 150 million gallons per day (mgd) at present. This is divided into about 80 mgd from groundwater and about 70 mgd from surface water. Estimates of the amount of additional groundwater available range as high as 100 mgd. Present problems with lowered groundwater level and high fluoride, chloride, and mineral content indicated that in practical terms there is almost no additional groundwater capacity. Low flow data for streams and rivers gives a rough indication of the additional supply available from surface water. About 140 mgd are available for consumptive use. The total available supply depending on the ability to reuse water is between 300 and 400 mgd. Use of this water without storage to maintain low flows would cause severe environmental damage. Effective storage could increase the potential water supply, while conservation could reduce demand.

Major Water Uses

As can be seen in Fig. 10a the western portion of the basin obtains its municipal and industrial water principally from surface sources. The central portion uses a mix of groundwater and surface water. And, the eastern portion relies almost entirely on groundwater. The entire basin withdraws about 54 million gallons per day (mgd) of groundwater and 48 mgd of surface water for municipal and industrial needs. Union Camp Corporation and Hercules Powder Company in Southampton County and the City of Franklin account for about 80 percent of groundwater use. The City of Norfolk's pumping plants on the Blackwater and Nottoway Rivers and Union Camp account for about 92 percent of the surface water use. The municipal and industrial water use in the Chowan-Pasquotank basins is on the average lower than the rest of Virginia and North Carolina. However, 86 percent of the water usage is within a ten mile radius of Franklin, Virginia.

Irrigation water withdrawals in the basin are relatively low at present, averaging an estimated 26 mgd through the year; withdrawals during the growing season are about 87 mgd. Of this total, half is in subarea 2 with Sussex County accounting for an estimated 27 mgd and Southampton 15 mgd. Nottoway County withdraws about 21 mgd. These figures represent average water use during the growing season. Actual usage is highly variable, depending on weather, cropping practices, and depth of topsoil.

Other domestic and agricultural uses account for around 16 mgd, divided evenly throughout the basins. This brings the total water usage to about 205 mgd during the growing season. This is a fairly low rate of water usage per square mile compared with the rest of the country. However, half this water comes from groundwater supplies. As a comparison only about 6 percent of the total combined water supply for Virginia and North Carolina comes from groundwater sources.

Wastewater discharges into streams and rivers follow the same pattern as water use (fig. 10b). The average discharge through the year adds up to about 60 mgd. This is less than the total for water withdrawals because of evaporation, seepage, interbasin transfers, and other water losses. About 72 percent of the total wastewater discharge is in the Franklin area. The major portion of this comes from Union Camp, which does not discharge in the summer.

Expected Future

Figure 11 shows the projected future demand and supply for water in the Chowan-Pasquotank basins. The total water supply is based on present groundwater usage, present reservoirs, present farm ponds and the 7 day - 10 year low flow within each subarea. The reduction in water supply in some subareas is due to increased water use upstream.

Present water needs in the Chowan-Pasquotank basins are being met largely by groundwater supplies. There is enough groundwater for future domestic supplies throughout the basins. There will not be enough groundwater for future municipal, industrial, and irrigation water demand. This is due to lack of groundwater in the Piedmont Region, overuse of groundwater in the Franklin area, and a high salt content in the coastal areas. Only in Washington and Tyrrell Counties will a significant increase in groundwater use be possible in the future. Although groundwater recharge from surface sources is possible, research is needed before this method can be used effectively.

Most future water needs will have to be met from surface water supplies. Direct pumping from rivers will supply a small portion of this need, but the large majority will require development of storage to last through low flow periods. There are considerable water quality problems during low flow periods under present conditions and direct removal of surface water during these periods would increase the problem.

An increased demand for irrigation water is projected in the future, but much of this will be met by farm ponds. Much of this demand will be due to economic pressures for increased crop yields and quality. Part of the demand for irrigation water may be related to the existing erosion damage.

Major Water Withdrawals

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

CHOWAN-PASQUOTANK RIVER BASINS

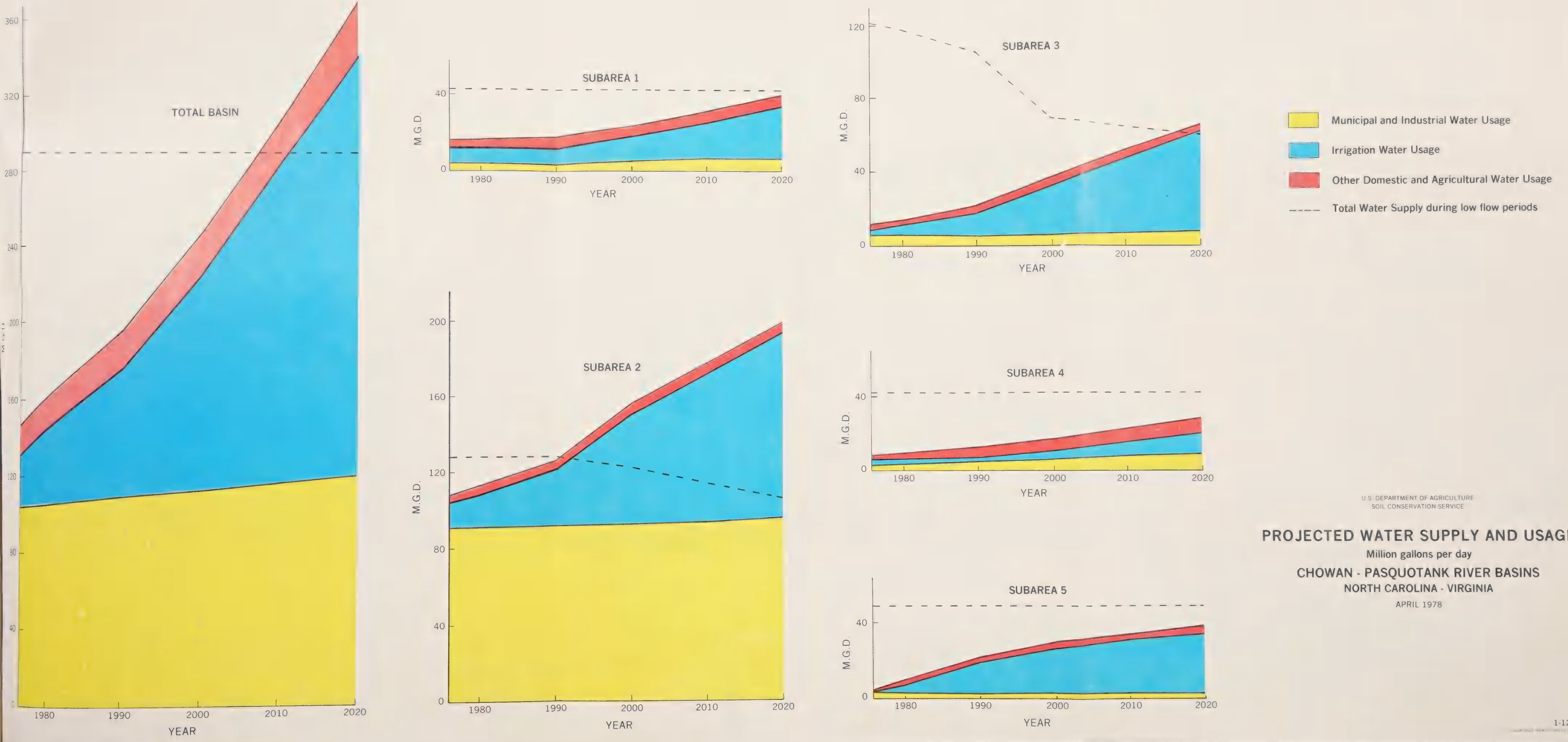
September 1976

Major Wastewater Discharges

BASE SOURCE - U.S. GEOLOGICAL SURVEY BASE MAP

1-13352

APRIL 1978



U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

PROJECTED WATER SUPPLY AND USAGE

Million gallons per day

CHOWAN - PASQUOTANK RIVER BASINS

NORTH CAROLINA - VIRGINIA

APRIL 1978

Where topsoil has eroded, the remaining soil cannot hold as much moisture. This increases the need for irrigation water. However, irrigation on sloping lands usually increases the erosion hazard. Also, land that has been drained to remove excess water may need water added during dry periods to maintain crop yields. Most of the municipal and industrial needs can be met by small reservoirs and storage ponds. However, the lack of readily available water supply may limit future industrial growth. No major reservoirs will be constructed within the basins in the near future unless the water supply for the Norfolk-Hampton Roads area is to come from the Chowan River basin. Projected water demands for Norfolk-Hampton Roads in million gallons per day are:

1976	1990	2000	2020
99.0	130.9	158.0	209.5

Present supply for this area is about 101 million gallons per day. By the year 2020 water demands within the basins and water demand by the Norfolk-Hampton Roads area may increase enough to require a major reservoir on one of the tributaries of the Chowan River. Thus far such a reservoir has not been economically, socially, or environmentally justified.

Water Quality

Ground Water

Good quality ground water is generally available throughout the basins. Some wells have high fluoride or dissolved solids levels in subarea 2. In subareas 3 and 4 there are wells with high iron or chloride levels. Some of the wells in the City of Virginia Beach and Tyrrell and Gates Counties are being polluted by septic tanks.

Surface Water

The quality of surface water is affected by pollution from point sources and non-point sources. Point sources are those that can be located and individually measured at a point, such as a pipe discharging sewage effluent. Some major point sources in the basins are Fort Pickett, the City of Franklin, Hercules Corp., and Union Camp Corp. Generally, the greater the discharge from a point source, the better the treatment facilities. Most remaining problems with point sources are in small communities with inadequate sewage treatment facilities. Most of these communities are scheduled to have improved facilities installed. However, increased population and increased sewage flows will tend to offset expected improvements in treatment.

Non-point sources include those that cannot be specifically located. These include runoff and sediment from cropland, urban areas, small feedlots, forests, roads, etc. The major non-point producer of sediment is cropland. The major non-point producer of nutrients (nitrogen, phosphorus, etc.) is unknown. Some comes from commercial fertilizers, animal waste, leaf litter, and from the soil. Cropland is probably the major non-point source of pesticides. Although pesticides that are in use today are not being monitored extensively in the streams, indications are that these pesticides are short-lived and usually do not present a serious water quality problem.

Every county within the basins except Washington and Hyde have had water quality readings that indicate problems. These readings cover a variety of problems, including low dissolved oxygen (D.O.), high nitrogen, high phosphate content, high fecal coliform counts, etc. Many of these problems are increased by the lack of secondary sewage treatment in many Virginia communities. An extensive program is under way to update the sewage treatment facilities in southeast Virginia. This will help to improve water quality to a certain degree. However, low D.O. is a natural condition for the Chowan-Pasquotank basins, due to extensive wetlands, sluggish flow, low base flow, and a long growing season. These factors make the basin sensitive to pollution from various sources.

Nutrients come from sewage, rural and urban runoff, and directly from rainfall. Nitrogen also comes from the air. A large portion of nitrogen comes from decomposed plants and animals in the water. This is called the background load. Estimates of the percent of nitrogen and phosphorus from various sources in an average year are shown in table 5.

Table 5 Estimated percent of nutrient load by subarea and source -- 1976 1/

Percent nitrogen load

Subarea	Percent	Source	Percent
1	18-22	Non-agricultural	2-3
2	22-26	Cropland	21-37
3	15-19	Pastureland	0-5
4	19-23	Forest land	7-20
5	18-22	Other agric. 2/	3-6
		Point Sources	1-2
Virginia	52-56	Rainfall	6-8
		Background	24-60
North Carolina	44-48		

Percent phosphorus load

Subarea	Percent	Source	Percent
1	23-27	Non-agricultural	6-7
2	29-33	Cropland	53-58
3	17-21	Pastureland	1-3
4	18-22	Forest land	22-26
5	6-10	Other agric. 2/	3-6
		Point sources	5-10
Virginia	63-67	Rainfall	0-2
		Background	0-2
North Carolina	33-37		

1/ See references, McElroy, A.D., et al.
2/ Includes animal wastes.

The various sources contribute nutrients at different times of the year. In late spring and early summer there is little runoff and growing plants are using the available nutrients. Point sources play a more important role at this time. Late summer storms increase the role of non-point sources. There is little rainfall in the fall and early winter, but falling leaves increase the forest's contribution then. Late winter and early spring have traditionally brought floods in the basins. At this time there are fewer plants to use the nutrients and little ground cover to prevent runoff and erosion.

Expected Future

If trends continue, erosion and the nutrient load from cropland in the future will decline slightly. HOwever, because of increased drainage on the highly organic soils in subarea 5 and an increase in livestock, the nutrient load from non-point sources will probably increase slightly in the future. In any case, fishing in Albermarle Sound will continue degrading because pesticide use is expected to increase.

Environmental Resources

Sport Fishing

The North Fork of the Meherrin River and Buckskin Creek in subarea 1 will support cool water fish such as smallmouth bass. The rest of the basins' streams support warm water fish. The dominant game fish include largemouth bass, bluegill, flier, warmouth, redfin pickerel, channel catfish, black crappie, and redbreast. Nongame fish include bullheads, longnose gar, suckers, chubsuckers, shiners, and darters. Estuaries in subareas 3, 4, and 5 provide spawning grounds for croaker, spot, mullet, striped bass, summer flounder, bluefish, and herring.

There is an abundance of fish within the basins, but access to freshwater fishing is limited. There are 7 boat access sites on the rivers in Virginia and 15 in North Carolina. Farm ponds, which are common in subareas 1 and 2, provide some fishing opportunities. Access is also limited in the bays and sounds. Along the coast, party boats, piers, and surf fishing provide excellent fishing opportunities.

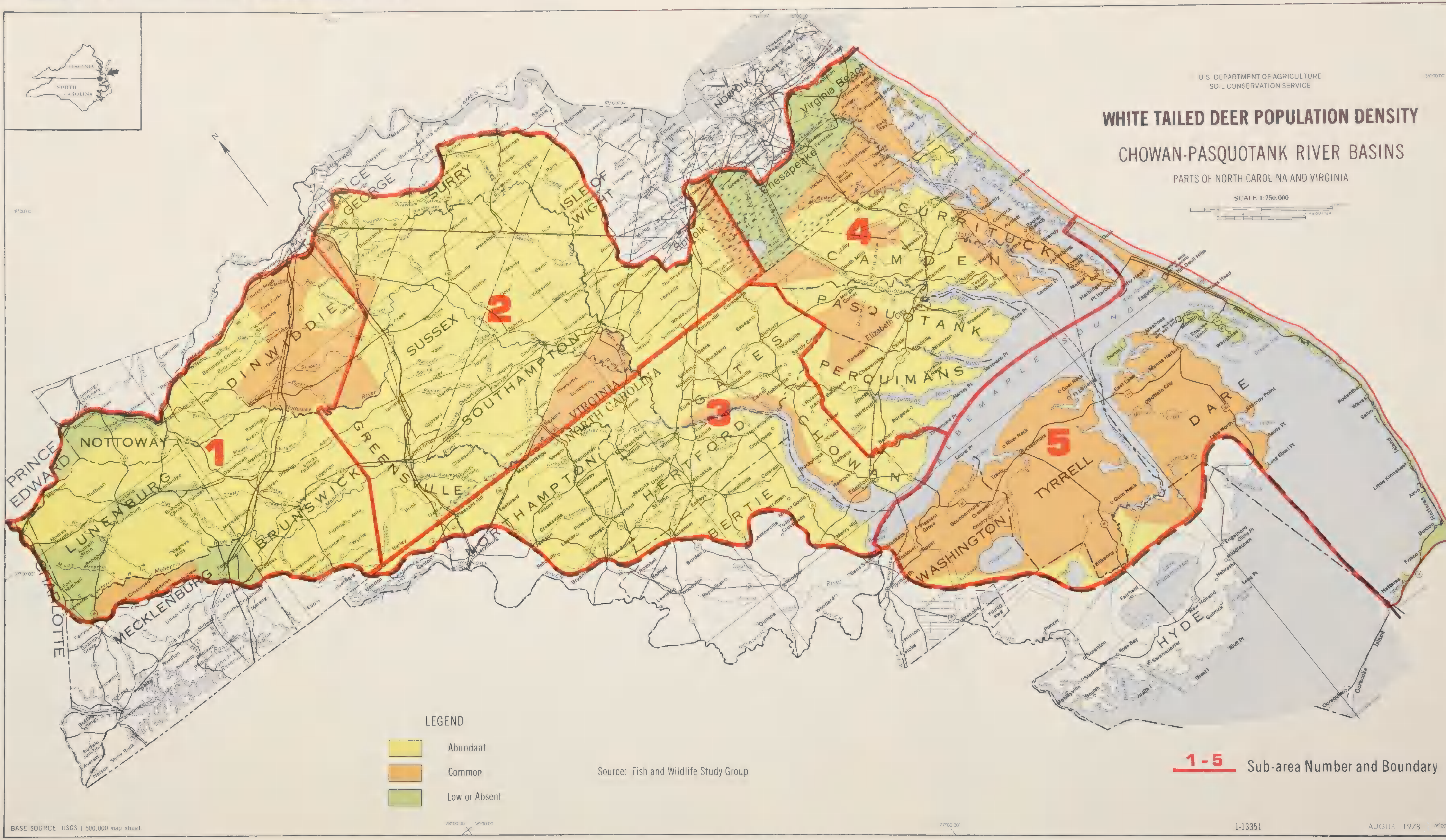
Table 6 shows the projected future capability and demand for sport fishing in man-days. Capability is an indication of the amount of fishing activity possible with full access to the waters of the basins. The demand for fishing exceeds the capability in subareas 1, 2, and 3. This indicates that care should be taken in increasing access sites in these areas. Subareas 4 and 5 have a large surplus capability, mainly due to Albemarle Sound. Increased access could encourage tourist fishing and benefit the local economy unless Albemarle Sound becomes more polluted.

Wildlife Resources

White-tailed deer, black bear, and wild turkey are the only big game species in the basins. Figure 12 shows that deer are common to abundant in most of the basins' forests. Deer are so plentiful in some areas, such as subarea 2, that they are causing damage to crops. Bears, on the other hand, are very scarce. There are about 200 bears remaining in the wetland forests. As shown in figure 13, most of them are in subareas 4 and 5.

Table 6 Projected sport fishing capability and demand, Chowan-Pasquotank River Basins

	1976		1990		2000		2020	
	Capa-bility	Demand	Capa-bility	Demand	Capa-bility	Demand	Capa-bility	Demand
				Thousand Man-days				
Subarea 1	77	652	123	743	145	758	216	779
Subarea 2	149	1042	150	1142	168	1148	184	1159
Subarea 3	384	629	393	629	405	630	427	654
Subarea 4	2099	643	2101	727	2101	792	2104	899
Subarea 5	3226	243	3232	227	3236	230	3244	239
Va. Subtotal	821	1950	870	2223	910	2291	1000	2393
N.C. Subtotal	5114	1259	5129	1245	5145	1267	5175	1337
Total Basins	5935	3209	5999	3468	6055	3558	6175	3730


U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WHITE TAILED DEER POPULATION DENSITY
CHOWAN-PASQUOTANK RIVER BASINS
PARTS OF NORTH CAROLINA AND VIRGINIA
SCALE 1:750,000
LEGEND
Abundant
Common
Low or Absent
Source: Fish and Wildlife Study Group
1 - 5 Sub-area Number and Boundary
BASE SOURCE USGS 1:500,000 map sheet
1-13351
AUGUST 1978
VIRGINIA
NORTH CAROLINA
NOTTOWAY
PRINCE EDWARD
LUNENBURG
CHARLOTTE
MECKLENBURG
BRUNSWICK
DINWIDDIE
PRINCE GEORGE
SURRY
SUSSEX
ISLE OF WIGHT
SOUTHAMPTON
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PASQUOTANK
CAMDEN
CURRITUCK
DARE
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WASHINGTON
HYDE
Chesapeake
Virginia Beach
Norfolk
Suffolk
ALBEMARLE SOUND
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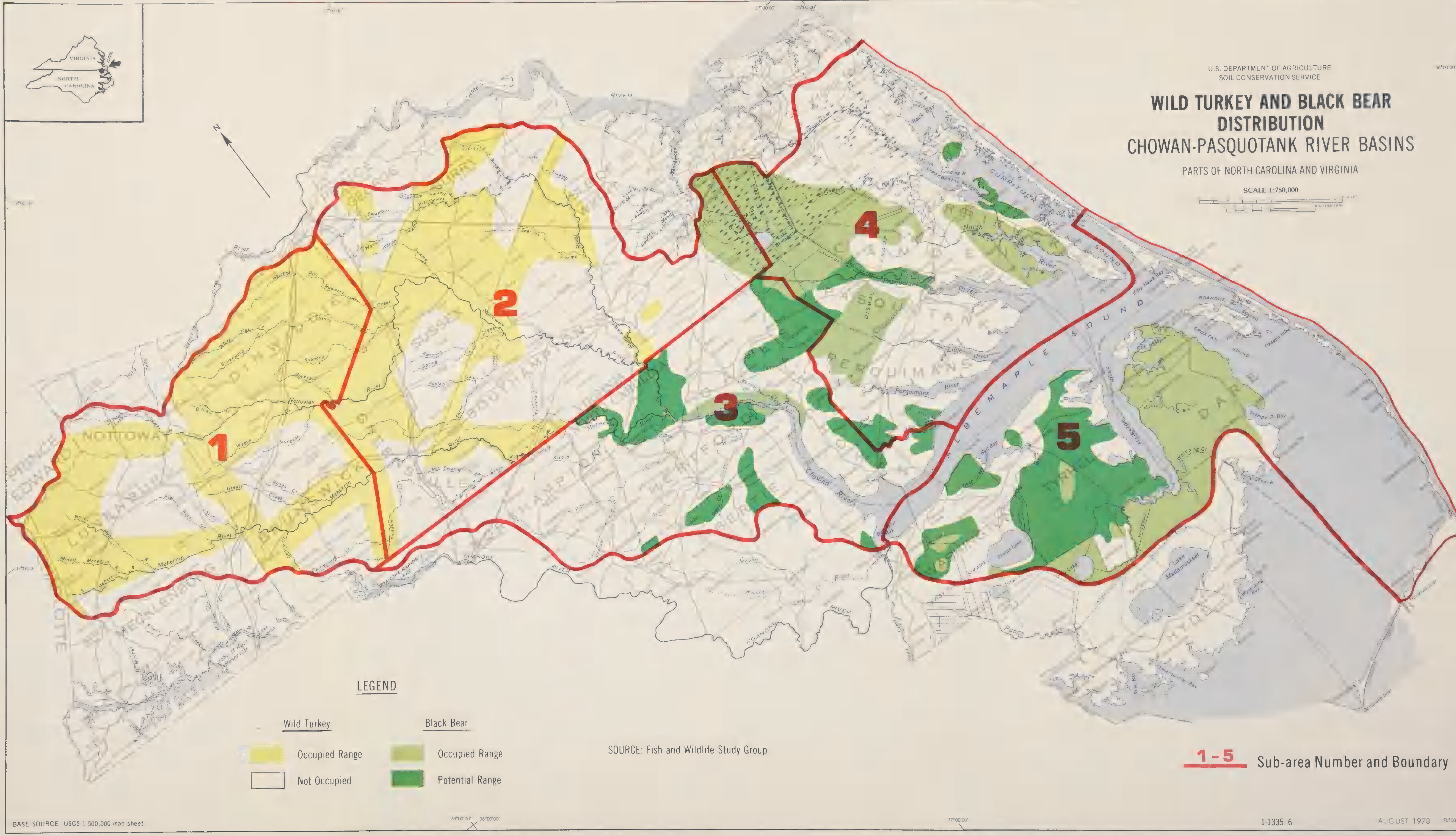

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
WILD TURKEY AND BLACK BEAR DISTRIBUTION
CHOWAN-PASQUOTANK RIVER BASINS
PARTS OF NORTH CAROLINA AND VIRGINIA
SCALE 1:750,000
VIRGINIA
NORTH CAROLINA
N
1
2
3
4
5
LEGEND
Wild Turkey
Occupied Range
Not Occupied
Black Bear
Occupied Range
Potential Range
SOURCE: Fish and Wildlife Study Group
1 - 5 Sub-area Number and Boundary
BASE SOURCE USGS 1:500,000 map sheet
1-1335 6
AUGUST 1978
ALBEMARLE SOUND
CURRITUCK SOUND
ROANOKE SOUND
CROATAN SOUND
NOTTOWAY
DINWIDDIE
SUSSEX
SOUTHAMPTON
PASQUOTANK
PERQUIMANS
CAMDEN
CURRITUCK
TYRRELL
DARE
Chowan River
Roanoke River
Meherrin River
Nottoway River
Lake Mattamuskeet
Phelps Lake

Small game includes rabbit, squirrel, quail, dove, fox, and raccoon. These are plentiful in all subareas. Rabbits are particularly abundant and cause extensive crop damage.

The coastal marshes in subareas 3, 4, and 5 support large numbers of migrating birds. Dabbling ducks, snow geese, Canada geese, and whistling swans feed in these areas. Wood ducks may be found in the wetlands through the basins.

Non-game Species

The state of non-game species usually mirrors the status of game species since habitat requirements are generally similar for the two groups.

In the past, non-game population levels throughout the basin were high primarily due to a diversity of habitat conditions. However, in recent times the trend toward large, unbroken monoculture crop fields and forests, plus the loss of wetlands have begun to have a negative impact, especially in the eastern portion of the basin.

If the present trends are projected into the future, non-game wildlife populations will continue to decrease, primarily in subareas 4 and 5.

Threatened and Endangered Species

Although animals such as deer and rabbits are abundant in the basins, there are other species threatened with extinction. Some of them are known to exist in the basins, but others such as the eastern cougar are so rare and elusive that their presence is only suspected (Table 7). Their status is considered endangered, threatened, or of special concern. Endangered species are those which are in danger of extinction throughout all or a significant portion of their range. Threatened species are those which are likely to become endangered within the foreseeable future. The category of special concern covers species that are reduced in number, very vulnerable, or never had a large population because of restricted habitat or other natural factors. Many of these plants and animals are concentrated around the Dismal Swamp. This is an unique area and supports some species that cannot be found elsewhere in the world.

Wildlife refuges such as the Dismal Swamp and Back Bay may preserve some of the endangered species. However, urbanization and drainage in the basins may mean extinction for many.

Table 7 Threatened and endangered species found or suspected in Basins

	Species	Status
Mammals		
	Eastern Big Eared Bat	SC 1
	Eastern Cougar	E 2,3
	Southern Bog Lemming	E 2
	Star-Nosed Mole	T 1
	Dismal Swamp	E 2
	Southeastern Shrew	E 2
	Pigmy Shrew	SC 1
Birds		
	Southern Bald Eagle	E 1,3
	Peregrine Falcon	E 1,3
	Sharp-shinned Hawk	T 1
	Black Rail	SC 2
	Yellow Rail	SC 2
	Ipswich Sparrow	SC 2
	Gull-billed Tern	SC 2
	Red-cockaded Woodpecker	E 1,2,3
Reptiles		
	American Alligator	E 2,3
	Canebrake Rattlesnake	SC 1
	Outer Banks King snake	E 2
	Atlantic Loggerhead Turtle	T 2,3
Fish		
	Atlantic Sturgeon	SC 2; T 1
	Roanoke Bass	SC 1
	Shortnose Sturgeon	E 1,2,3
Invertebrates		
	Millipede	E 2
Plants		
	Beard Grass	SC 1
	Cut Grass	T 1
	Kalmia cuneata	SC 2
	Panicum mundum	E 1
	Dwarf Trillium	SC 1
	Carolina Blubmoss	SC 1
	Glandular Lob Fern Hybrid	SC 1
	Atlantic White Cedar	SC 1
	Spanish Moss	SC 1
	Tradescantia rosea graminea	SC1
	Eleocharis bladwinii	SC 1
	Rhynchospora alba	SC 1
	Large-headed Rush	SC 1
	Lace-leaf Greenbrier	SC 1

Table 7 - Continued

Black Snakeroot	SC 1
Bog Rose	T 1
Spreading Pogonia	SC 1
Joint Grass	SC 1
Pale Wedge Grass	SC 1
Silky Dogwood	SC 1
Fen Orchid	SC 1
Pale Green Orchid	SC 1
Purple Fringless Orchid	SC 1
Shadow-witch	SC 1
Toothache Grass	SC 1
Muhlenbergia brachyphylla	SC 1
Muhlenbergia expansa	SC 1
Muhlenbergia glabriflora	SC 1
Panicum fusiforme	SC 1
Panicum mundum	E 1
Panicum strigosum	SC 1
Panicum wrightianum	SC 1
Paspalum praecox	SC 1
Sphenopholis filiformis	SC 1
Sporobolus junceus	SC 1
Justicia mortuifluminis	T 1
Ilex coriacea	SC 1
Dwarf Ginseng	SC 1
Hexastylis Lewisii	T 1
Echinacea laevigata	SC 1
Iva imbricata	SC 1
Hudsonia tomentosa	SC 1
Virginia Pinweed	T 1
Diamorpha smallii	E 1
Pyxie Moss	SC 1
Large Cranberry	T 1
Live Oak	SC 1
Wild Olive	SC 1
Portulaca smallii	E 1
Blue Jasmine	SC 1
Spearwort	SC 1
Yellow Water Crowfoot	SC 1
Buttercup	SC 1
Ranunculus laxicaulis	SC 1
Sarracenia flava	T 1
Pajysalis viscosa maritima	SC 1

T - threatened
E - endangered
SC - special concern
1 - of concern in Virginia
2 - of concern in North Carolina
3 - of concern nationally

Agricultural Production

Livestock

Livestock have traditionally been important in the basins, particularly in subareas 2 and 4. Estimates of future production for whole county areas are shown below. [1/]

Livestock production for whole county areas

	1976	1990	2000	2020
		Million pounds		
Beef and veal	58.8	72.0	79.1	93.1
Pork	203.4	253.0	275.0	325.7
Chicken	4.6	3.8	3.8	2.9

Pork will continue to be one of the major products of the area. Production is much greater than the local demand and pork will continue to be a valuable export. Beef production is about equal to local demands at present. By 2020 there may be a slight excess production for export. Chicken production is much less than the local demand now and production is falling. Chicken production is falling throughout the State of Virginia.

Crops

The major crops in the basins are corn, wheat, soybeans, and peanuts. Estimated future production for whole county areas is:

Crop production for whole county areas

		1976	1990	2000	2020
			Millions		
Corn Bu.		35.8	36.1	49.7	59.9
Peanuts	Lb.	543.5	904.1	1024.4	1098.1
Soybeans	Bu.	12.4	25.1	33.7	36.6
Tobacco	Lb.	52.9	67.3	67.0	83.5
Wheat	Bu.	3.3	3.3	3.6	3.8

[1/] The "whole county" areas include the set of conterminous counties in North Carolina and Virginia, the outside boundary of which most nearly approximates the boundary of the Chowan-Pasquotank River Basin.

Corn acreage is increasing only slightly with most of the increased production coming from increased per acre yields. The situation is similar with peanuts. Soybean acreage and yields are increasing. The increased acreage is from newly cropped land and from double cropping -- wheat followed by soybeans. Although tobacco and wheat yields are increasing, the acreage is decreasing. Other crops such as hay and sorghum are decreasing in acreage and production. Truck cropping has increased in subareas 4 and 5 recently. It cannot be determined at this time whether this trend will continue.

Production trends in the basins reflect the nationwide trend toward more grain and oil crops. Corn, peanuts, and soybeans are the dominant crops today and will be even more important in the future. The projections do not take into account the loss of production due to erosion damage.

Forest Industries

In 1976, over 40 million dollars worth of timber was cut in the basins. This timber was used for paper, lumber, veneer, and plywood valued at over 200 million dollars. Future production is estimated to be:

	1976	1990	2000	2020
Cut (mil. cu. ft.)	182.5	186.4	192.4	204.5
Value (mil. dollars) 1/	40.3	41.2	42.5	45.2

Present timber production is about 1.5 times the local demand. By 2020 production will be slightly less than the local demand. Presently subarea 2 contains the greatest volume of the more valuable timber. However, subarea 1 has the greatest concentration of sapling stands. These factors will cause economic adjustments in the future, but these are not the most important factors. Presently about 55 percent of the timber cut is softwood. Under present price structure this trend should continue until 2020.

Stumpage prices for softwood are twice the prices for hardwood. Softwood is being cut faster than it is being grown. Many commercial forests are being high-graded; the better trees are cut and low quality, low value trees are left behind. Most regeneration occurs naturally, resulting in more acres of low quality hardwood. If present trends continue, there will be few softwoods or high quality hardwoods remaining in 2020.

1/ Based on stumpage prices in 1975.

Commercial Fishing

Anadromous fish in Albemarle Sound are the major source for commercial fishing in the basins. These are saltwater fish which spawn in freshwater and include river herring, striped bass, and shad. The catch in 1973 was over eight million pounds. In 1977, the catch was slightly over seven million pounds. Other commercially important fish are catfish, rockfish, and white perch. The value of commercial fishing is estimated to be about five million dollars annually. Most of the fishing industry is centered in subarea 3, where the world's largest river herring processing plant is located.

Shellfishing was important at one time in Albemarle Sound. However, in 1975 the Sound was closed to shellfishing because of pollution. In recent years algal blooms in the Sound and in the Chowan River have reduced commercial fishing. The algal blooms have not caused significant fish kills, but have fouled nets and clogged motors on the fishing boats. Catfish are becoming more numerous and other species are dwindling. This appears to indicate that the quality of the water is declining.

An outbreak of red sore disease, a bacterial infection of fish, is reaching epidemic proportions in the Chowan River Basin. The disease has been linked to deteriorating water quality and some commercial fish catches are completely contaminated. A direct link has not been made between algal blooms and this disease, which can be fatal to fish and in rare cases, people. However, steps taken to eliminate the blooms will probably help protect the commercial fishing industry from the red sore disease.

Recreation

Supply

The Chowan-Pasquotank basins have an abundance of beaches, water area, and scenic areas. Publicly owned recreation areas include:

- Subarea 2
  - Charles C. Steirly National Area
  - Dismal Swamp National Wildlife Refuge (also in Subarea 4)
- Subarea 3
  - Merchants Millpond State Park
- Subarea 4
  - Back Bay National Wildlife Refuge
  - Dismal Swamp State Park
  - False Cape State Park
  - Mackay Island National Wildlife Refuge
- Subarea 5
  - Cape Hatteras National Seashore
  - Jockey Ridge State Park
  - Pea Island National Wildlife Refuge
  - Pettigrew State Park

Most of these parks are located along the coastline and provide recreation for local people and a large number of tourists. Urban and residential development has been growing rapidly in the coastal areas. National and state parks have been growing also, to meet recreation demand and to protect wildlife.

Demand

The demand for recreation is being met along the coast, but it is not being met in the rest of the basins' area. Table 8 shows the present supply and projected demand for recreation in acres. Overall the supply of recreation exceeds the demand, but over half the total supply is located in subarea 5. The lakes along the Roanoke River also provide a large portion of the recreation needs. Subarea 5 and recreation spots outside the basin can meet the demand for weekend recreation. However, it cannot meet the need for playgrounds, picnic areas, and bicycle paths.

Expected Future

Table 8 does not reflect future parks and scenic rivers proposed by the states. These proposed sites include: three parks in subarea 2; one park and two scenic rivers in subarea 3; two parks and one scenic river in subarea 4; and two scenic rivers in subarea 5. Future recreation supply will be abundant in subarea 5. The supply should be close to the demand in subarea 4. The proposed parks in subarea 2 should supply most of the future demand. New recreation areas are planned in subarea 3, but water based recreation has been affected by the algae blooms in the Chowan River. Although there is an apparent lack of recreation areas in subarea 1, no state parks have been proposed.

Hunting

Most hunting occurs on land owned by farmers and forest industries, but there are many publicly owned hunting areas. Some of these are: Fort Pickett Military Reservation, Back Bay, False Cape State Park, and Bodie Island.

Projections of hunting capability were based on land use and hunting demand was based on population in the basins. Table 9 shows the percent of demand that can be met in the future. On the average, the capability for hunting is 300 to 500 percent of the demand. There is a shortage of capability for bear hunting, and human population increases will cause a slight shortage in quail hunting. Deer and rabbits will continue to be abundant. Capability and demand projections for individual species are given in the technical appendices.

The population of game animals in general is expected to exceed the hunting demand in the future.

Table 8 Present supply and projected demand for outdoor recreation areas

Subarea	1976 Supply	1976 Demand	1990 Demand	2000 Demand	2020 Demand
			Acres		
1	790	4105	4675	4770	4900
2	2965	6555	7185	7220	7290
3	2050	4135	4090	4130	4290
4	4555	4020	4670	5080	5755
5	18,535	1600	1495	1520	1575
VA subtotal	8,005	12,270	13,995	14,590	15,050
NC subtotal	20,890	8,145	8,120	8,130	8,760
Total basins	28,895	20,415	22,115	22,720	23,810

Table 9 Percent of hunting demand that can be met with projected capability

	1976	1990	2000	2020
Subarea 1				
Big game	399	343	377	326
Small game	390	339	331	317
Waterfowl	17	17	18	19
Subarea 2				
Big game	293	264	264	263
Small game	304	313	275	272
Waterfowl	20	19	19	19
Subarea 3				
Big game	326	325	316	289
Small game	349	350	344	322
Waterfowl	117	118	118	114
Subarea 4				
Big game	217	181	156	119
Small game	350	291	266	221
Waterfowl	1148	1014	931	821
Subarea 5				
Big game	677	697	655	559
Small game	701	745	720	668
Waterfowl	3438	3700	3645	3490
Virginia subtotal				
Big game	299	258	251	239
Small game	334	307	280	265
Waterfowl	203	180	175	168
N. C. subtotal				
Big game	383	384	360	311
Small game	425	425	408	372
Waterfowl	1018	1036	1011	960
Total basins				
Big game	332	298	290	265
Small game	370	349	324	303
Waterfowl	523	486	473	452

CHAPTER 4
PROBLEMS AND SPECIFIC OBJECTIVES

Erosion

The average amount of soil worn away each year by rainfall, streambank erosion, and shoreline erosion totals about 14.2 million tons under 1976 conditions (Table 10). If we piled all this soil on one acre of land, the pile would be about 1.25 miles high. And we would have to create a new pile every year. Erosion in the future is expected to decrease slightly, under ongoing land treatment programs. Soil loss will be about 14.1 million tons a year by 1990, 14.0 million tons a year in the year 2000, and 13.8 million tons a year by 2020. In other words, after 44 years our annual pile of soil will be 200 feet shorter.

The greatest erosion occurs on cropland. A great part of this is due to the fact that most cropland is not properly managed for erosion control.

Properly treated and managed land should lose less than about five tons of soil per acre each year. At this level, natural processes will replace the lost soil. The average erosion rate for cropland in the Chowan-Pasquotank basins is about 10 tons per acre each year. In some areas the erosion rate is as high as 50 tons per acre each year. Silage corn has the highest erosion rates because few residues are left on the field and it is grown on marginal land. Second highest is tobacco, followed by peanuts, soybeans and grain corn. The highest erosion rates occur in subarea 1, where the steepest slopes are located.

Cropland acreage is increasing in the flatter areas of subareas 4 and 5, while decreasing in the other subareas. This will lower the overall erosion rates, but most cropland will still be inadequately treated. The major problem in these subareas is soil wetness. Also in these subareas, the huge open fields are susceptible to wind erosion during dry periods.

Roadbank erosion is a significant problem in the Chowan-Pasquotank River Basin. Severe erosion occurs along many of the steep, poorly vegetated roadbanks during heavy storms. There would be little erosion problem if the roadbanks had originally been graded properly and if proper maintenance were practiced. Instead of mowing, the roadbanks are scraped periodically which destroys existing vegetation.

Only a small portion of the total erosion occurs on forest land. However, almost a third of the total forest erosion occurs on roads and skid trails in subarea 1.

About two thirds of the erosion listed under other rural land is shoreline erosion along the Chowan River and Albemarle Sound. Although shoreline erosion is a small portion of the total erosion, it has a large significance. Shoreline erosion contributes large quantities of sediment, nutrients and organic matter directly into Albemarle Sound. Part of this erosion is caused by continental subsidence which can not be controlled.

Table 10 Present and projected gross erosion, Chowan-Pasquotank River Basins

	1000 tons per year			
Subarea 1	1976	1990	2000	2020
Non-agricultural	58	63	70	86
Cropland	2,946	2,917	2,705	2,361
Pastureland	45	49	44	33
Forest land	615	600	604	605
Other agric. 1/	59	51	43	34
Subtotal	3,723	3,680	3,466	3,119
Subarea 2				
Non-agricultural	40	41	41	43
Cropland	3,316	3,141	3,032	2,854
Pastureland	16	20	18	15
Forest land	320	313	315	319
Other agric. 1/	34	49	46	38
Subtotal	3,726	3,564	3,452	3,269
Subarea 3				
Non-agricultural	11	12	15	21
Cropland	2,754	2,521	2,344	2,066
Pastureland	6	3	2	1
Forest land	161	160	156	146
Other agric. 1/	217	214	366	242
Subtotal	3,149	2,910	2,883	2,476
Subarea 4				
Non-agricultural	15	25	30	41
Cropland	2,234	2,437	2,664	3,031
Pastureland	5	3	2	1
Forest land	80	75	68	55
Other agric. 1/	411	444	439	413
Subtotal	2,745	2,984	3,203	3,541
Subarea 5				
Non-agricultural	9	9	10	13
Cropland	540	700	823	1,096
Pastureland	1	1	2	2
Forestland	58	54	51	43
Other agric. 1/	222	208	207	207
Subtotal	830	972	1,093	1,361

Table 10 Present and projected gross erosion, Chowan-Pasquotank River Basins - Continued

	1000 tons per year			
Virginia	1976	1990	2000	2020
Non-agricultural	104	115	124	146
Cropland	6,822	6,679	6,394	5,917
Pastureland	64	71	63	49
Forest land	946	925	925	921
Other agric. 1/	144	171	157	124
Subtotal	8,081	7,960	7,806	7,158
North Carolina				
Non-agricultural	28	35	42	58
Cropland	4,968	5,037	5,174	5,491
Pastureland	9	5	5	3
Forest land	288	278	269	246
Other agric. 1/	799	795	801	810
Subtotal	6,092	6,150	6,291	6,608
Total study area				
Non-agricultural	133	150	166	204
Cropland	11,790	11,716	11,568	11,408
Pastureland	73	76	68	52
Forest land	1,234	1,202	1,194	1,168
Other agric. 1/	943	966	1,101	934
Total	14,173	14,110	14,097	13,766

1/ Includes streambank and shoreline erosion.

The objective for erosion reduction should be to decrease wind, sheet, and rill erosion to maintain soil depth on all land, even if this means conversion of some cropland to other uses in some critical erosion areas. Critical shoreline erosion areas in Albemarle sound and the Chowan River should be identified and treated to reduce erosion and sediment. Roadbanks need to be regraded to a flatter slope and seeded with conservation plants that will grow well in the basins. Possible selections are: "Tioga" deer tongue, "Lathco" flatpea, tall fescue, weeping lovegrass, crownvetch, and sericia lespedeza. The modification of timber harvesting and site preparation techniques should be encouraged to reduce forest soil erosion. Properly designed and located logging roads and skid trails, for example, will limit steep gradients and reduce disruptions of natural drainage contours. Critical erosion prone areas can be seeded and mulched following logging to insure quick site revegetation.

Sediment

Most of the soil lost by erosion does not travel very far in one year. It is deposited at the edge of fields or in flood plains long before reaching Albemarle Sound. Much of this sediment enriches the soil on the bottomlands, at the expense of the uplands. Only rarely does sediment deposition lower the fertility of flood plain soils.

Sediment deposits in some channels damage fish spawning beds and make floods more frequent and more damaging. Sediment fills in reservoirs, reducing their capacity for water supply and flood control and increasing water treatment costs. A prime example is the Emporia Reservoir. The sediment and the associated nutrients lower water quality and contribute to the algal blooms in Albemarle Round and the Chowan River. This damages fishing, boating, and swimming.

The related objective is to reduce the transport of sediment and associated nutrients to a level that will stabilize stream channels, improve fisheries, and help prevent algal blooms in the rivers and the Sound.

Flood Hazard Areas

Flooding in subarea 1 is partly due to sediment deposition in the channels. Most of this flooding occurs in narrow, wooded valleys and causes little damage. There is occasional flooding in Lawrenceville, but damages are minor. A major cause of flooding in subareas 2 and 3 is debris jams that clog the channels. Debris jams on the major rivers are cleared periodically to maintain a navigation channel. As a result, the higher flood crests occur on the tributary streams. Most of the flood plains are wooded wetlands, which suffer little damage from flooding and help reduce flood levels in downstream communities. The towns of Stony Creek, Courtland, Murfreesboro, and the cities of Franklin and Emporia suffer flood damages. These damages are greatest in Emporia, where the flood of October 1972 caused $40,000 in damages and where there are few upstream wetlands.

In subareas 4 and 5 flooding from storm runoff and streamflow is not a problem. Flooding is caused by high tides and poor drainage. The cities of Chesapeake, Virginia Beach, and Elizabeth City are subject to significant damages from tidal flooding. Flood damage to urban areas is expected to increase as these areas grow. The Virginia Beach area in particular, may suffer tremendous damages from future flooding and wave action.

Although flood damage in the basins has been significant, no major flood control structures have been built. Flooding problems occur on widely scattered areas of land. Structures to prevent this flooding would cost more than the flood damages. Large flood control structures have been investigated within the basins. They have rarely proved economically and environmentally feasible.

Cropland acreage in the flood plains has decreased over the past years, but several thousand acres are still subject to flooding.
Estimates of the average annual flood damages to agriculture in the basins in 1976 dollars are:

	1976	1990	2000	2020
Virginia	$288,000	$303,000	$309,000	$317,000
North Carolina	$315,000	$330,000	$336,000	$346,000

The projected increase in damages is primarily due to the expected increase in crop yields. The number of agricultural acres subject to flooding are expected to decrease in the future.

The objective for flood control should be the most cost effective mix of structural and non-structural measures to eliminate the hazard of loss of life from the 1 percent probability flood and reduce physical flood damages by about 50 percent. Also, wetlands and flood plain forests should be protected to conserve their natural flood protection values.

Drainage

Soil wetness is a major limitation on land use in the Chowan-Pasquotank basins. Drainage would increase crop yields on about 302,000 acres of cropland. This represents about 4 percent of the cropland in subareas 1, 27 percent in subarea 2, 26 percent in subarea 3, 36 percent in subarea 4, and 29 percent in subarea 5.

The amount of yield increase that can be gained with drainage depends on the degree of wetness, the type of soil, and the crop. Potential yield increases range from as low as 8 percent to as high as 68 percent. Increases of 30 to 40 percent are typical.

Under ongoing programs, the amount of cropland needing drainage will decrease to about 271,000 acres in 1990, 262,000 in 2000, and 247,000 in 2020. Unless a new program to protect wetlands is developed, many acres with a wetness hazard will be converted to cropland from other uses by private landowners. Under existing regulations some of this land will be eligible for federal assistance for drainage within 5 years. Since increased crop yields usually justify the expense of on-farm drainage practices, they can be installed without government financial assistance. Technical assistance should still be provided to help prevent system failures and downstream pollution. However, group project action with some financial assistance in frequently required to provide sufficient outlets for the on-farm drainage systems.

The USDA objectives should be to accelerate its programs to help design drainage systems for cropland and provide financial assistance for group project drainage outlet facilities. The purpose of this should be to encourage the construction of systems which will minimize adverse effects on adjacent wetlands or natural channels.

Water Supply

Many localities within the basins need additional water supply now or will need it in the near future. In most areas surface water is readily available but is not being used to its capacity, while groundwater is either unavailable or being used to capacity in most areas. Along the coast ground and surface water supply is being used to its capacity, specifically in Virginia Beach, Chesapeake, and North Carolina outer banks. This will probably not stop growth along the coastline and will not stop the demand for water. State and local governments or private companies will develop water supplies for these areas. Programs to encourage water conservation are needed. There are communities where a safe source of water is readily available and where there will be a need by 1990. Such communities include Jarrett, Va.; Kenbridge, Va.; Burkeville, Va.; and Seaboard, N.C. Improved water supplies in these communities would encourage development in areas with low average income and fewer environmental problems.

Water Quality

Groundwater

The major threat to ground water quality within the basins is salt water intrusion. Large amounts of water are being pumped out of the ground in the Franklin area. This pumping has lowered the water level and caused a wedge of salt water to move in from the ocean. At present the water level is stationary and so is the wedge of salt water. The State of Virginia has restricted further groundwater use in the area. This situation should remain stable, but additional large water supplies must come from surface waters. The objective for groundwater quality is to maintain the present monitoring program and enforcement of state and local government restrictions. The development of surface water storage should be encouraged to decrease demands on groundwater. Possibilities for groundwater recharge should be investigated.

Surface Water

The major surface water quality problem is excessive nutrients causing algal blooms in the Chowan River and Albemarle Sound. Short-lived algal blooms in late spring and summer have been common in the past. In 1972, a severe bloom started in May and lasted until fall. Similar blooms have occurred several times since then. The main ingredients needed for algae blooms are sunlight and nutrients (nitrogen and phosphorus). The recent algal blooms in the Chowan River are thought to be caused by increased nutrient releases and runoff during the past few years.

The current land treatment programs help improve water quality. Several communities are scheduled to have improved sewage treatment plants. However, these programs alone will not solve water quality problems by 2020. Accelerated programs of land treatment, animal waste management, improved fertilizer management, and integrated pest management are essential to reduce agricultural non-point source pollution, to prevent or reduce the severity of algal blooms, and to minimize sediment damages to the fishery in Albemarle Sound and the Chowan River.

Wetland Preservation

Much of the basin, especially from the central to the eastern subareas, has historically been in wetlands. At present, much of the tidal influenced wetlands have effective laws to prevent significant losses from dredge and fill. Current policy also limits impacts on federally funded or assisted practices. For example, USDA assistance is available to drain existing croplands but may not legally be used to drain wetlands. However, there are few constraints on drainage of wetlands by private landowners in non-tidal areas. As a result many acres of wetlands, especially bottom-land hardwoods, are being lost through conversion to cropland and urbanization annually.

The Chowan-Pasquotank basins have historically been valuable preserves for unique forms of vegetation and threatened and endangered wildlife species. The large expanses of relatively undisturbed wetlands and woodlands have provided an effective buffer against human impacts in the past. However, present trends indicate a rapid loss of habitat due to land use conversion, especially in subareas 4 and 5. Future projections indicate these trends will continue.

The objective would be to encourage more local ordinances which restrict wetland conversion by the private sector. An education and information program to explain the value of wetlands would be an important component of this objective.

As many diverse habitats as possible, should be preserved, especially bottom-land hardwoods and other vegetative types not presently being protected. Preservation of whole ecosystems should be encouraged rather than isolated "islands" of habitat set aside for a particular species; although this may be needed in some instances. Specifically, expansion of purchase and easements programs, both private and government, should be developed in fragile areas. Effective land use planning, including local ordinances to preserve all forms of wetlands, should be encouraged.

Energy

The more important energy resources in the basins are firewood, peat, wind, agricultural wastes, and solar. Local sources of energy remain largely undeveloped. Large amounts of imported energy are used in present agricultural practices. This energy is used directly as fuel and indirectly as commercial fertilizer.

The objectives should be to develop an effective system to distribute energy information to rural areas to encourage development of local energy sources. The use of wood for fuel should increase to an extent consistent with improved forest management. Conservation of energy and use of alternative energy on farms should be encouraged, especially where this may help reduce non-point source pollution. Research has shown that ethanol and methane production, and use of solar and wind energy can be economically incorporated into many farm operations. Conservation tillage practices which reduce fuel usage should be encouraged. Improved livestock waste management to reduce the use of commercial fertilizers should be encouraged.

Recreation

There is a large variation in recreation potential between different subareas of the basin. Recreation has not developed as a major concern of the study. Private development assisted by ongoing programs will probably provide sufficient outdoor water related recreation facilities. However, the development of recreation facilities should be considered in the planning of solutions to other problems, such as wetland preservation, prime agricultural lands, forest management, shoreline erosion control, etc.

Timber Supply

High quality hardwood and softwood timber supplies will continue to decrease throughout the basins in future years unless changes occur in forest management trends. To maximize economic returns, logging operations in hardwood stands often concentrate on the removal of large, high-value trees only. Timber left standing in such cases is typically of small size and poor quality. Future yields of such stands are characterized by relatively low volumes of less-than-desirable trees. Through the use of proper harvesting and regeneration techniques, greater long-term yields of quality hardwood sawtimber could be realized. More intensive management is required in softwood and mixed softwood-hardwood stands, which are often ignored after harvest. Unless efforts are made to insure growth of softwood species on suitable sites, many cutover areas will continue to regenerate to low quality hardwood species. The application of softwood regeneration techniques will be necessary to reverse a historical trend of declining softwood stand acreage in the basins. The use of wood as a source of energy offers new opportunities to realize quick returns from forest management practices such as timber stand improvement.

CHAPTER 5
ALTERNATIVE PLANS AND MANAGEMENT OPTIONS

Cropland Erosion Reduction

In this study a linear programming model was developed to evaluate various management practices for cropland erosion control. [1/]

The factors used in the LP analyses included soils information, crop yield rates by soils, production costs, fertilizer use, pesticide use, energy costs, costs of erosion control practices, and erosion rates. Since most economic data are only available by county areas, the model was developed for an area of conterminous counties which most nearly approximated the hydrologic boundary of the study area. The land acreages therefore are somewhat larger than the data shown in Table 3. Since it is believed that with strong public support a land treatment plan could be completed by 1990, all of the program solutions were developed for the target year. The solutions are designed to provide guidance for basinwide programs but are not specific enough to guide individual land owners. Technical assistance for individuals will still need to be tailored to specific sites, soils, land uses, and management objectives encountered on each land unit.

For most of the solutions, the objective was to reduce erosion at least cost. All of the least cost solutions were constrained to meet forecasted levels of agricultural production for principal crops (See Chapter 3). Only sheet and rill erosion on cropland was addressed in the L-P models. Solutions for least cost, minimum energy usage and least cost, minimum pesticide usage were also developed. A solution for meeting a 7 ton per acre per year average annual erosion rate with maximum profits is also shown in Table 11.

An estimate of 1990 conditions under present trends and management and the forecasted level of agricultural production provides the basis for comparison. Five other programs were compared with this model to estimate the effects of instituting new or accelerated land treatment programs.

1. Maximum Allowable Erosion Rates - Maximum allowable erosion rates were set for all soil units. Three levels of such limits were modeled. The levels chosen were 10, 7, and 4 tons per acre per year. The 4 ton limit was impossible to obtain while meeting forecasted agricultural production. The 4 ton solution shown in Table 11 presumes to all over 56,000 acres to have erosion rates exceeding an average of 4 tons per acre per year. On about 12,000 acres of chisel-plowed corn grain, sheet and rill erosion averaged 16.7 tons per acre per year. If the 4 ton limit has been strictly held in spite of loss of production, the erosion reduction would have been about 75 percent instead of 64 percent. Production and profits would be lower and costs probably higher.

[1/] A linear programming model (LP model) is a computerized mathematical procedure which allows for the simultaneous evaluation of the relationship between several economic variables.

2. Maximum Allowable Erosion Totals - The levels modeled were 24, 48, and 72 percent reductions in total erosion from the base condition. In this concept, no land unit is given a limit for an erosion rate. This may even allow some erosion areas to remain untreated. The most cost effective practices would be applied first. For example, the 24 percent reduction solution shows that total cropland erosion could be reduced 24 percent simply by applying contour cultivation to 323,000 acres and no-till farming to 73,000 acres of row crops at a cost of only $300,000 per year. Reducing basin wide cropland erosion by 48 percent by the least cost methods would require practices with amortized installation costs of about $500,000 and increased farm production costs of about $2,300,000 per year for a total annual incremental cost of about $2,800,000. This compares roughly with a 9 ton limit and a cost of about $15,000,000 per year if modeled by the maximum allowable per acre concept in (1) above. The added costs of obtaining further erosion reductions rise very rapidly as winter cover, terracing, and more land use shifts are required to meet more stringent program objectives.

3. Minimum energy - The objective of this alternative was to use as little energy as possible. For this solution erosion was constrained to levels comparable to the lowest levels achieved above (1 and 2). This constraint would have resulted in a solution with even less use of energy but with much more erosion. This solution, when compared to the 4 ton limit solution, helps to illustrate the cost effectiveness of a program tied to overall erosion reduction rather than to maximum limits for each land unit. This minimum energy program is not the least cost program because of the estimated high use of herbicides and insecticides. Hazards related to the use of pesticides must be considered before selecting this kind of program.

4. Minimum Pesticides - The objective of this solution was to minimize exposure to pesticides. The erosion constraint used for this solution was not the same as for the minimum energy solution so a direct comparision cannot be made. The analysis indicates considerably more conventional tillage when less pesticides are used for the same level of production.

5. Maximum Profit - This solution maximizes farmers' profits subject to a 7 ton per acre erosion limit. It shows how an erosion reduction program might be combined with other recommendations so that the costs of erosion control can be offset by increasing production to raise profits. By increasing the acreage of wheat, corn grain, and hay, net profits can be raised by 7 percent. However, total direct and indirect costs would also increase. This combination would only work if the increased production in this basin did not depress market prices to the point of offsetting the anticipated increased profits. Programs for federal cost sharing in this level of program would have to be tempered with a consideration for inter-regional effects.

Table 11 displays the conservation practices and effects of some alternative programs for control of sheet and rill erosion on cropland in the basin.

The objective for erosion reduction as stated in Chapter 4 is to limit sheet and rill erosion to less than 5 tons per acre per year on all lands. The 4 ton limit program described in Table 11 is closest to this objective. Installation of the practices described in this program would cause more severe changes in cropping practices, land treatment needs, and costs. The 4 ton limit solution calls for the greatest increase in fertilizer use if the projected agricultural production is to be obtained. An alternative not shown is to lower agricultural production by converting cropland to pasture, hay or forest where present erosion rates are high. This might be done at less cost but might also reduce income. The 72% basin erosion reduction program appears to be much more reasonable. None of the programs described in Table 11 include practices for roadbank, shoreline, streambank, wind, or snowmelt erosion.

Sediment

The sediment related objective is to reduce the transport of sediments and attached nutrients to a level that will stabilize stream channels, improve fisheries, and help prevent algal blooms in the rivers and Albemarle Sound. This objective will probably be achieved if the erosion control objective described above is met. However, another erosion control program may be selected which allows erosion to exceed the rates in the 4 ton limit solution. In this event, some sediment control practices such as vegetated field and stream borders and sediment detention ponds may be needed near locations where erosion rates remain high.

Flooding

The objectives for reducing flood hazards were to minimize the chance of loss of life and to reduce in property damage by 50 percent. The minimum energy solution will reduce flood discharge by about 9 percent on the average basinwide. The depth of flooding will be reduced about 3 percent on the average. In areas where flooding is due to sediment filling the channels, a land treatment program can reduce the sediment load, cause the channel to degrade, and significantly reduce flood damages.

However, in most areas land treatment will have little effect on flood damages. Other alternatives for flood protection include:

Flood Warning - Warning is generally available through weather service bulletins on radio and television. The possibility of escape routes being flooded before evacuation should be examined in highway design and in flood hazard studies. Flood warning networks are quite effective in saving lives and automobiles but are relatively ineffective in reducing other kinds of property damages.

Flood Insurance - Although insurance reduces personal liability it does not reduce total property damage. Insurance, without enforced flood plain zoning encourages redevelopment in the flood plain and consequently does not meet the objectives.

Table 11 - Some Alternative Management Programs for Cropland Erosion Control - 1990 Conditions

	Maximum Allowable Erosion Rates: 4 Ton/Acre Limit	7 Ton/Acre Limit	10 Ton/Acre Limit	Reducing Total Basin Cropland Erosion: 24% reduction	48% reduction	72% reduction	minimum energy	minimum pesticide	Maximum Profit with 7 Ton/Acre Erosion Limit
	thousand acres								
Practices 1/									
winter cover	417.2	236.4	62.0	0.0	39.0	748.8	309.1	114.9	42.6
contour cultivation	13.7	56.3	175.3	323.3	335.3	226.2	29.0	16.2	148.1
strip crop	4.3	13.1	15.9	0.0	0.0	0.0	26.7	1.1	4.1
contour strip	23.3	31.3	11.8	0.0	29.3	56.8	0.0	0.0	18.1
no-till	230.2	356.8	243.0	73.0	544.5	705.7	620.9	615.0	571.8
chisel plow	295.6	292.5	156.2	0.0	0.0	0.0	234.9	182.6	291.1
terrace	157.0	186.9	138.6	0.0	0.7	341.4	652.5	241.6	403.8
no-till/terrace	542.6	20.4	33.1	0.0	0.0	185.5	327.3	85.0	60.2
no-till/strip	0.0	3.3	0.0	0.0	0.0	0.0	13.4	0.0	1.2
Physical Effects	Percent Change								
erosion	-64	-56	-44	-24	-48	-72	-69	-38	- 57
N fertilizer	+19	+ 3	+ 0	+ 0	+ 0	+ 1	+ 2	+ 4	+144
P fertilizer	+ 3	+ 0	+ 0	+ 0	+ 0	+ 1	+ 2	+ 2	+ 34
K fertilizer	+ 8	+ 2	- 1	- 0	- 1	+ 3	- 1	+ 0	+ 25
ALTI 2/	- 9	- 6	+ 5	+ 0	- 8	-23	-22	-36	- 16
WEBER2 3/	+ 4	+ 1	- 1	+ 0	- 0	- 1	+ 0	- 4	+ 2
fuel energy	- 1	- 5	- 0	+ 1	- 5	- 5	- 8	- 2	+ 15
fert. energy	+10	+ 1	- 0	- 0	- 0	- 0	- 1	+ 2	+ 64
pest. energy	+ 3	+ 0	+ 0	+ 0	- 1	- 2	- 1	- 6	- 4
total energy	+ 4	- 2	- 0	+ 0	- 2	- 3	- 4	- 1	+ 37
flood discharge	- 6	- 2	- 1	- 0	- 0	- 4	- 9	- 3	N/A
sediment delivery 6/	-70	-54	-44	N/A	N/A	N/A	-89	N/A	N/A
Economic Effects	thousands acres								
total cropland 4/	1604.4	1488.6	1481.3	1474.6	1479.9	1479.2	1510.9	1516.9	1557.6
	million dollars								
direct cost	$26.8	8.7	6.1	0.1	0.5	18.8	20.8	9.6	13.8
indirect cost 5/	$34.6	12.6	7.1	0.2	2.3	23.8	29.8	14.6	52.9
profits	$223.5	262.9	265.6	N/A	N/A	N/A	248.0	N/A	281.7

1/ More than one practice may be used on any one acre.
2/ Index of potential effects of pesticides on mammals.
3/ Index of potential effects of pesticides on fish.
4/ Variation is due to an imposed requirement of meeting the agricultural production in chapter 3. Solutions are for whole county areas and total acreage is about 20 percent higher than cropland within the basin.
5/ Increased cost of production for the farmer.
6/ This is the estimated reduction of sediment delivery from sheet and rill erosion on cropland. Sediment deliveries may also be reduced by trapping sediment in vegetated strips and reducing erosion from other areas.

Flood Plain Zoning - Zoning can limit the increase in flood damages, but does little to reduce them.

Undeveloped Property Right Aquisition - Like zoning, aquisition of undeveloped properties can be effective in limiting future damages but does not reduce present damages. This practice is usually combined with land use changes, for example, to recreation or parking.

Flood Proofing - When feasible, flood proofing can be a very effective method of reducing flood damages. However, flood proofing can give a false sense of security and increase the chances of loss of life.

Property Relocation - Relocation is very effective, but it is also very expensive and often causes strong public opposition. Relocation leaves an undeveloped area with limited uses. This usually creates a new land management situation in the area.

Storm Water Retention - This usually applies to an urbanizing situation. As presently practiced, retention prevents runoff from increasing as development occurs. It has little effect on present damages.

Emergency Restoration and Disaster Relief - Like flood insurance this reduces personal liability while frequently restoring the potential for flood damages. This program should be more closely linked to the installation of other nonstructural alternatives to reduce future flood hazards.

Channel Improvement - This can be very effective in reducing damages from frequent flooding, particularly in an urban area. Channel work may have little effect on larger floods. Channel work alone would not reduce damages by 50 percent in this basin.

Dikes and Levees - Like channel improvement, dikes can be very effective in reducing damages and are usually more cost effective.

Flood Storage Reservoirs - Dams can be physically very effective for reducing both urban and agricultural flood damages. Dams generally have not proven to be cost effective for flood control in the basins. Offstream reservoirs fed by canals or spillways have not been examined in detail and may prove to be feasible. High dams on streams also create a risk associated with their possible failure and have a limited useful life. Other purposes such as water supply or hydropower should be included in proposed dams when possible.

In summary, structural measures identified are not cost effective in enough sites to reduce total damages by 50 percent. Non-structural measures are usually ineffective in reducing damages or are socially unacceptable. To reduce damages by 50 percent it is necessary to combine structural measures where feasible, with flood proofing, relocation flood insurance, and zoning programs. To help eliminate loss of life, highways should be designed and bridges improved to insure evacuation routes.

Wetland Preservation

The objective for wetland preservation is to protect all existing wetlands. Present emphasis on wetland preservation has resulted in many regulations and ordinances and has greatly reduced the rate of conversion. Further laws would be of some benefit on the local level. There will be some loss of wetlands even with more regulations. A program of wetland construction would be necessary to replace those losses. Management options include:

a. Government purchase and protection of selected wetland areas, with assistance through the Resource Conservation and Development Program of the Soil Conservation Service.
b. State government restrictions on water supplies and sewage systems.
c. State and local government zoning and building restrictions.

Water Supply

The objective for water supply is to develop surface water supplies in rural communities with a need and a readily available source. Various alternatives for meeting this objective are:

Direct Pumping of Water from Streams - This method is satisfactory only when the water demand of the community is not large enough to impair the low flow needs for fish and wildlife.

Reservoirs - Instream dams in most areas are not economically, environmentally or socially justified. Off-stream storage, such as the town of Kenbridge uses, may be a satisfactory solution.

Water Conservation - Conservation methods can be an excellent "source" of water supply and can also reduce the quantity of waste water that needs to be treated. Flow reducers in showers and low volume toilets in new contruction and changes in rate structure are particularly cost effective.

Aquifer Recharge - Most aquifer recharge projects have been built in limestone areas which would not apply to the Chowan-Pasquotank Basins. However, drilled holes to the aquifer level are possible. This may be cost effective when combined with flood control reservoirs.

Communities should be examined individually to determine the extent that their needs can be met by conservation and offstream storage.

Water Quality

The water quality objective is to reduce sediment and nutrient transport, stabilize stream channels, and maintain the basins' fishing potential. A review of the erosion control program alternatives indicates that the 72 percent reduction solution is the best water quality alternative. This solution offers the greatest reduction in total erosion, and nitrogen and phosphorous application. This solution provides a significant reduction in potential effects of pesticides, even though pesticides have not been considered a problem in the Chowan-Pasquotank basins. In addition, an educational program to improve the timing of nitrogen fertilizer application and encourage integrated pest management is needed.

The 72 percent erosion reduction solution is not the most economically effective level for obtaining sediment reduction. The 48 percent reduction or 7 ton per acre limit alternatives obtain more reduction in sediment deliveries per dollar spent on cropland erosion control. These levels in erosion reduction may be sufficient to stabilize stream channels, reduce algal blooms, and improve fisheries to an acceptable level.

Energy

The objective for energy is to encourage energy self-sufficiency on farms and to develop firewood production. Energy self-sufficiency can only be achieved through the use of renewable resources. Small scale production of energy can be handled by the individual farmer if he has the proper information. This information ideally should be channeled through existing organizations, such as the Cooperative Extension Service, Farmers Home Administration, Agricultural Stabilization and Cooperative Service, or Soil Conservation Service. Medium scale production of energy should be handled through the Rural Electrification Administration, the Farm Bureau, local districts, or small business. Legislation is pending in Congress to permit low head hydropower development in small watershed projects.

The Forest Service and the State Divisions of Forestry need to study the available supply and projected demand for firewood. This study should include an assessment of the potential effects on prices and supply of lumber and paper.

The computer solution for minimum energy indicates the type of conservation practices and effects consistent with an emphasis on reducing energy consumption.

Timber Supply

To insure long-term supplies of quality timber available for industrial use, more intensive forest management should be promoted throughout the basins. It is necessary to develop and implement an agressive public information program aimed at increasing landowners' awareness of the potential benefits of proper forest management. Ongoing state and federal assistance programs should emphasize regeneration needs of sites best suited to softwood growth; and proper timber stand improvement, harvest and regeneration practices needed in hardwood stands. Particular attention should be paid to hardwood management needs in bottomland forests. Under proper management, erosion control and energy objectives may be served.

Harvest and regeneration operations, for example, can be planned to reduce site disturbance and the potential for increased erosion. Depending upon individual stand characteristics, fuelwood production may provide immediate financial returns from timber stand improvement. Information and technical assistance provided to individual forest owners will be necessary to stimulate interest in, and the accomplishment of, the needed increases in timber management activity.

Alternative Plans

Table 12 is a summary of the concerns and objectives listed in this study. Table 13 shows the effects of single purpose alternative plans and the conflicts involved in trying to meet all the objectives.

Table 12 - Summary of Concerns and Objectives

Problem	Objective
Erosion	5 tons per acre or less on all land
Sediment	Reduce to stabilize stream channels, improve fisheries and help prevent algal blooms in Albemarle Sound.
Flooding	Eliminate loss of life and reduce property damage by 50% from the 1% chance flood.
Wetland Preservation	Protect existing wetlands
Water Supply	Develop readily available supply where there is a need.
Water Quality	Meet legal standards and maintain fishing.
Energy	Farmer self-sufficiency and develop firewood production.
Timber Supply	Increase quality hardwood and softwood timber supplies.

Table 13 - Effects of Elements of Single Purpose Alternative Plans

Concerns	Erosion Plan	Flood Control	Water Supply Plan	Water Quality Plan	Wetland Preservation	Energy Plan
	Effects					
Erosion (Cropland)	64% decrease	no effect	no effect	72% decrease	helps to prevent increase	69% decrease
Sediment	70% decrease	slight decrease	no effect	50% decrease	helps to prevent increase	45% decrease
Flooding	6% decrease in discharge	0-70% decrease in peak discharge dependent in location	0-10% decrease in peak discharge dependent on loc.	4% decrease in in peak discharge	helps to prevent increase	9% decrease in peak discharge
Water Supply	reduced irrigation needs lower treatment cost	possibility for multiple purpose structures	will meet 1990 needs except in subarea 4 Va.	reduced irrigation needs lower treatment cost	helps maintain groundwater levels	reduced irrigation needs lower treatment cost
Water Quality	sediment -70% nitrogen +19 phosphorus +3% pesticide +4%	decreased sediment decreased nutrients	decreased sewage	sediment -50% nitrogen -1% phosphorus -1% pesticide -1%	maintain natural treatment areas	sediment -45% nitrogen +2% phosphorus +2% pesticide +0%
Wetlands	possible decrease due to channel degredation	decrease	no significant effect	possible decrease due to channel degredation	protects wetlands	possible decrease due to channel degredation
Energy	4% increase	possibility for low-head hydroelectric power	pumping required for new supplies, no energy increase for conservation	3% decrease	no effect	4% decrease
Wildlife habitat	increased food, cover and diversity pesticide -9%	decreased habitat	decreased habitat	increased food, cover, and diversity pesticide -23%	maintains present habitat	increased food, cover and diversity pesticide -22%

Table 13 - Effects of Elements of Single Purpose Alternative Plans - Continued

Concerns	Erosion Plan	Flood Control	Water Supply Plan	Water Quality Plan	Wetland Preservation	Energy Plan
Recreation	sediment reduction improves waterbase recreation	possibility for recreation lakes	slight improvement	reduction in sediment and potential for algae blooms	improves passive recreation	sediment reduction
Timber Supply	helps maintain productivity potentials	structural measures could possibly reduce forest acreage	no significant effect	no significant effect	helps maintain forest acreage and wetland tree	may help promote proper hardwood management
Economics 2/						
Direct Costs	26.8 million	0.8 million	0.6 million	18.8 million	0.2 million	20.8 million
Indirect Costs	34.6 million			23.8 million		29.8 million
Social Effects	maintain yield levels on all land. Difficult to fully implement	possible public opposition to structures	does not meet the needs of coastal areas	difficult to fully implement	public opposition due to desire for cropland drainage and development pressures	difficult to fully implement

1/ See Table 11 in Chapter 5 for the practices that relate to the Alternative Plans for Erosion, Water Quality, and Energy Plans. See the other appropriate topics in Chapter 5 for general descriptions of programs for the other single purpose alternative plans. 2/ Average Annual Costs

The plan elements that have the greatest economic benefits form the National Economic Development (NED) plan (table 14). The NED plan consists of elements from the Water Supply Plan, the Water Quality Plan, the Wetland Preservation Plan and some elements of the Flood Control Plan and the Energy Plan.

The water supply elements will provide economic growth to rural communities and reduce the pressures for growth in the Norfolk area. The water quality elements provide the most cost effective method of protecting the fishing industry in Albemarle Sound. Also, through the extensive use of conservation tillage, energy consumption will be reduced and crop yields may increase. Wetland preservation is the most cost effective, large-scale method of flood prevention in the basins. Flood proofing and energy conservation should be promoted through information programs.

The plan elements that have the greatest environmental benefits form the Environmental Quality (EQ) plan. The EQ plan consists of elements of the Erosion Plan and the Wetland Preservation Plan.

The erosion elements preserve the productive capability of the land for future generations. The wetland preservation elements preserve wildlife habitat.

The suggested plan is essentially the NED plan. Some portions of the erosion control element have been added.

Table 14 displays the principal effects of the NED, EQ, and suggested Plans. None of these Plans will completely meet all of the resource objectives as stated in Chapter 4 and summarized in Table 12. The suggested plan is proposed as a reasonable compromise between objectives and economic effectiveness.

A principal focus of this study is land treatment for erosion control. The USDA approach to this problem should be: (1) Help implement the most cost effective measures first. (2) Provide crop management information and financial cost sharing to help offset the costs of applying these practices. (3) Assist water quality monitoring programs of other agencies to help estimate the effectiveness of the land treatment program. (4) Assist the more costly practices only in critical erosion areas for the time being. (5) Assist the more costly practices on cropland only when the need for sediment reduction justifies such practices.

Table 14 - Alternative Plans

Concerns	National Economic Development		Environmental Quality		Suggested Plan	
	Principal Elements	Estimated Effects	Principal Elements	Estimated Effects	Principal Elements	Estimated Effects
Cropland Erosion	No acceleration of erosion control practices.	0	Practices described for 72% reduction of cropland erosion (Table 11). Treatment of critical areas, roadbanks.	-72%	Practices described in Table 11 for 48% reduction of cropland erosion, treatment of critical areas and roadbanks.	-42%
Sediment Transport	No acceleration of sediment control practices.	0	Erosion control above plus vegetated border strips to trap sediment.	-50%	Erosion control above plus vegetated border strips to trap sediment.	unknown
Flooding Damages	Multipurpose reservoirs plus levees and floodproofing. Some wetlands used as reservoir sites. Some channels enlarged.	$ to - 70% occasional risk to life	Reduced flooding through improved watershed vegetation from erosion control elements. Flood warning. Relocation from flood plain.	$ to - 100%	Erosion control above plus flood plain zoning, flood insurance, flood proofing, levees, and minimum relocation.	$ to - 50%
Water Supply	Water Conservation Education. Offstream storage for Kenbridge, Jarrett, Burkeville, Seaboard. Multipurpose reservoirs where feasible for flood control. Groundwater recharge project.	Sufficient supply for growth of small towns and cities. Maintain water quality and supply for large cities.	Offstream reservoirs only. Water Conservation measures enforced by local gov'ts	Maintain low flow instream flows. Improve fisheries. Protect Coastal Acquifers	Active program for water conservation education. Some Coastal Communities with ordinances requiring water saving devices in homes and businesses. Water supply storage for Kenbridge, Jarrett Burkeville, Seaboard. Groundwater recharge in wetland areas	Protect coastal plain acquifers. Improve water supply for smaller communities.

Table 14 - Alternative Plans - Continued

	National Economic Development		Environmental Quality		Suggested Plan	
Concerns	Principal Elements	Estimated Effects	Principal Elements	Estimated Effects	Principal Elements	Estimated Effects
Water Quality	Find and reduce sources of nitrogen affecting fishery in Chowan River and Albemarle River.	Improved commercial fishery.	Erosion control as described above. Find and reduce non-point sources of nitrogen.	Improved land and water quality and commercial fishery.	Same as EQ	
Wetlands	Provide flood proofing for developments of wetland.	Higher land values.	Prevent development or drainage of wetlands.	Protected fish and wildlife habitat.	Develop program to help acquire selected wetland areas for perm. wildlife habitat. Provide information about hazards related to development of wetlands.	
Energy	Encourage development of local sources of energy and combine sales of firewood with good forest management practices to maximize annual benefits over a long term. Develop hydropower.		Same as NED except hydropower.		Same as NED.	

Table 14 - Alternative Plans - Continued

	National Economic Development		Environmental Quality		Suggested Plan	
Concerns	Principal Elements	Estimated Effects	Principal Elements	Estimated Effects	Principal Elements	Estimated Effects
Wildlife Habitat	None		Wetland preservation plus vegetated border strips as in sediment above. Provide other nesting, feeding, breeding, and cover areas.		Same as EQ.	
Recreation	Provide recreation facilities whereas profitable.		Limit recreation access and sites to protect environment and habitat.		Provide those recreation facilities which are most compatible with protecting the environment and the quality of recreation.	
Timber Supply	Combine timber management practices with benefits from sale of firewood.		Same as NED.		Same as NED.	

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